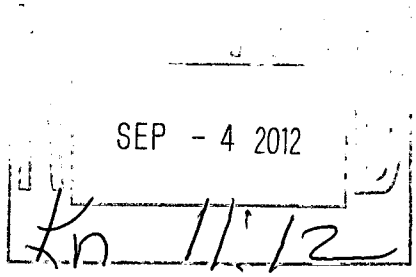
CDM Smith

1401 West Capitol
Suite 230
Little Rock, AR 72201
tel: 501-374-1620
fax: 501-374-2110

August 31, 2012

Mo Shafii
Assistant Chief
Water Division
Arkansas Department of Environmental Quality
5301 Northshore Drive
North Little Rock, AR 72118-5317




**RE: City Corporation Pollution Control Works Improvements**
**Schedule II – Nitrate Removal**

Dear Mr. Shafii:

On behalf of City Corporation, submitted herewith and pursuant to the Corrective Action Plan for compliance with Consent Administrative Order LIS No. 09-146 is the construction permit application including one (1) set of plans and specifications for the referenced project for your review and approval. In addition for your technical review we have supplied a copy of a memo which outlines the design calculations and approach for the proposed improvements associated with this project.

In accordance with the requirements of Regulation No. 6, plans and specifications have also been submitted to the Arkansas Department of Health (ADH) for approval. A copy of the written request seeking approval from ADH has been included with this submittal.

I hope that you will find the provided information adequate for your review and approval. Should any further information be needed, please let me know as soon as possible. Further, if you need clarification or have any concerns, feel free to call me anytime. Due to the time limitations associated with this the implementation of these improvements; City Corporation respectfully requests that this application be given your department's immediate attention. If there is anything that we can do to help expedite the permitting process, please let us know.

Sincerely,

Andrew J Pownall

Andrew Pownall, P.E.
**CDM Smith**

Enclosures: Permit Application Binder
Plans and Specifications –1 Set

CC: Craig Noble – City Corporation
CDM File (109678-89452-4.4.4)

City Corporation
RW Russellville Water & Sewer System
&SS

**100% Submittal**
**SPECIFICATIONS**

# City Corporation Russellville
# Schedule II – Nitrate Removal
# Project No. 89452

*Prepared by:*
CDM Smith Inc.
8140 Walnut Hill Lane, Suite 1000
Dallas, TX 75231
Firm Registration No. F-3043

City Corporation

August 2012

CDM Smith

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# *DIVISION 0*

# *BID& CONTRACT REQUIREMENTS*

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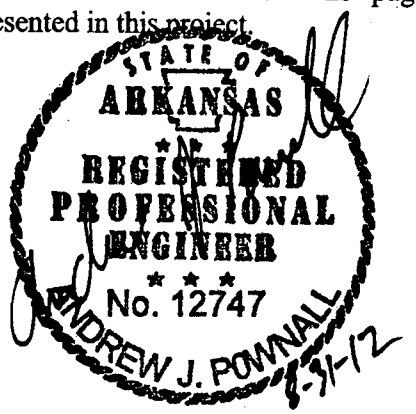
SECTION 00007

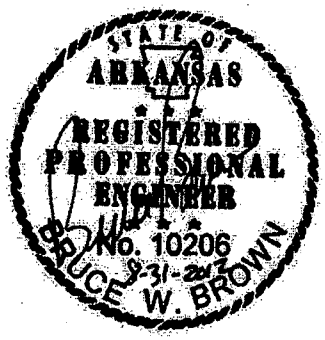
SEALS

The professional license seals listed on this page represent design responsibility for plans and specifications represented in this project.

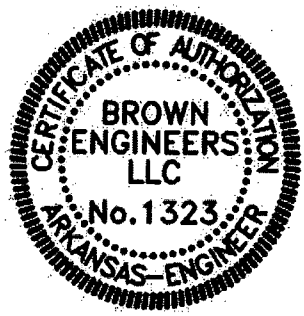



Andrew J. Pownall, P.E.
Arkansas License No. 12747
CDM Smith, Inc

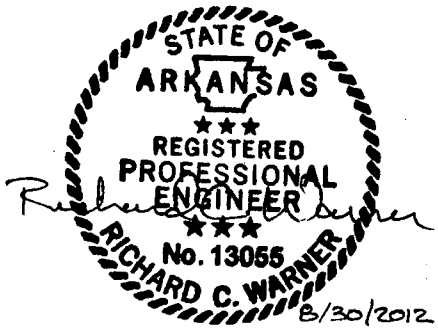
Camp Dresser & McKee, Inc.
Certificate of Authorization
No. 209




Bruce Brown, P.E.
Arkansas License No. 10206
Brown Engineers, Inc.




Brown Engineers, Inc.
Certificate of Authorization
No. 1323




Richard C. Warner, P.E.
Arkansas License No. 13055
CDM Smith, Inc

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SECTION 00030

INVITATION TO BID

Sealed Bids addressed to the City Corporation, will be received at the **Pollution Control Works, 404 Jimmy Lile RD, Russellville, Arkansas 72802**, until **2:00 P.M. LOCAL TIME, February 28, 2013** and then publicly opened and read for furnishing all plant, labor, material and performing all Work required to construct **Pollution Control Works Improvements Schedule II – Nitrate Removal**.

Bids received later than the specified time and date will be returned to the bidder unopened. The opened bids will then be officially reviewed, evaluated, and recommended for award to City Corporation thereafter.

Major requirements associated with this project are:

1. Distribution Structures.
2. Aeration Basins.
3. Secondary Clarifiers.
4. RAS/WAS Pump Stations.
5. Electrical building.
6. Demolition and site work.

All bid proposals, as well as the Bid Bond, must be made on the printed document forms included in the specifications. The submitted bid shall not be altered, withdrawn, or resubmitted within 60 calendar days from and after the date of the bid opening. Bid Bond Documents submitted with contract must be on the forms provided in the bid packets.

Contractor's Bid shall be accompanied by a cashier's or certified check upon a national or state bank in an amount not less than five (5) percent of the total maximum Bid Price, payable without recourse to City Corporation, or a Bid Bond in the same amount from a reliable surety company, as a guarantee that the Bidder will enter into a Contract and execute Performance and Payment Bonds within ten (10) days after Notice of Award of Contract. The Notice of Award of Contract shall be given by the Owner within sixty (60) days following the opening of Bids.

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The successful Bidder must furnish a Performance Bond and Payment Bond upon the forms provided each in the amount of One Hundred (100) Percent of the Contract Price from an approved surety company holding a permit from the State of Arkansas to act as surety, or other surety or sureties acceptable to the Owner.

Bidders, subcontractors, and suppliers may obtain copies of the bid invitation with information to bidders, bid proposals, plans and/or specifications from CDM (501) 374-1620, with a non-refundable deposit of $200.00 per set which includes one (1) full size set of drawings and specifications. No Plans, Specifications, and Bidding Documents will be sent without the payment of the deposit.

Bidders will be required to inform themselves of all addenda duly issued. Information regarding the number of addenda, which have been issued, can be obtained from CDM, (214) 346-2800.
City Corporation reserves the right to reject any and all bids and to waive defects in bids.

For information concerning the proposed work, contact Mr. Matt Crow, P.E., CDM Smith., 8140 Walnut Hill Lane, Suite 1000, Dallas, TX 75231, Telephone (214) 346-2800.

Minority and small business vendors or contractors are encouraged to bid on any and all City Corporation projects.

A non-mandatory pre-bid conference for this project will be held at the **Pollution Control Works Administration Building, 531 Jimmy Lile RD, Russellville, Arkansas 72802, on February 13, 2013 at 1:00 P.M.**

Advertisements scheduled **January 27 and February 10, 2013**.

Attention of Bidders is particularly called to the requirement as to conditions of employment to be observed and minimum wages to be paid under the Contract as incorporated in these Specifications.

Bidders are cautioned that Bids for this Project are subject to compliance with Arkansas Law for construction of Public Works as found in Arkansas Code Annotated 22-9-101, etc. The Bidder shall thoroughly acquaint himself/herself and comply with the provisions of these Acts.

The right is reserved, as the interest of the Owner may require, to reject any or all Bids and to waive any informality in Bids received. Bidders must be licensed in compliance with Arkansas Contractor's Licensing Law found in Arkansas Code 17-25-101, etc.

Plans, Specifications, and Bidding Documents may be examined at the following locations:

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City Corporation
Russellville
205 West 3rd Place
Russellville, AR 72801
Phone No. (479) 968 –2105
Call for appointment between hours 8:00 a.m. to 3:00 p.m.

CDM Smith
Little Rock
1401 West Capitol
Suite 230
Little Rock, AR 72201
Phone No. (501) 374-2519
Call for appointment

The plans and specifications located at City Corporation and CDM Smith Little Rock are available for viewing only. No copies will be provided.

Any contract or contracts awarded under this invitation for bids will be subject to the requirements of the State of Arkansas Competitive Sealed Bidding as described in the contract documents.

END OF SECTION

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SECTION 00100

INFORMATION FOR BIDDERS

PART 1: GENERAL

1.01 DEFINED TERMS

A. Terms used in these Instructions to Bidders which are defined in the Standard General Conditions of the Construction Contract have the meanings assigned to them in the General Conditions. The term "Bidder" means one who submits a Bid directly to Owner, as distinct from Sub-Bidder, who submits a Bid to a Bidder. The term "Successful Bidder" means the lowest, qualified, responsible and responsive Bidder to whom Owner (on the basis of Owner's evaluation as hereinafter provided) makes an award. The term "Bidding Documents" included the Advertisement or Invitation to Bid, Information for Bidders, the Bid Form, and the proposed Contract Documents (including all Addenda issued prior to receipt of Bids).

1.02 COPIES OF BIDDING DOCUMENTS

A. Complete sets of Bidding Documents in the number and for the deposit sum stated in the Advertisement or Invitation to Bid may be obtained from the Engineer. Deposit for Bidding Documents is non-refundable.

B. Complete sets of Bidding Documents shall be used in preparing Bids; the Owner does not assume any responsibility for errors or misinterpretations resulting from the use of the incomplete sets of Bidding Documents.

C. The Owner in making copies of Bidding Documents available on the above terms does so only for the purpose of obtaining Bids on the Work and does not confer a license or grant for any other use. All Bidding Documents shall remain the property of the Owner and Engineer, and any use of the Bidding Documents for any purpose other than the bidding of the Project is strictly prohibited.

1.03 QUALIFICATIONS OF BIDDERS

A. Owner shall also consider the following criteria in evaluating the Bidder's qualifications following the opening of Bids.

1. Financial Responsibility.

2. Experience and performance records on similar work.

3. Ability to supply construction equipment and personnel to complete the Work within the Contract Time.

4. Evidence of Bidder to do business in the State of Arkansas. All Bidders must be licensed under the terms of Act 150 of the 1965 Acts of the Arkansas Legislature, including subsequent amendments.

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B. Bidders may be requested to submit financial statements after the Bid opening. Such statements shall be submitted to Owner within three (3) days after being so requested.

C. Only those Bids will be considered which are submitted by Bidders who show satisfactory completion of work of type and size comparable to the Work required by these Bidding Documents.

1. A list of comparable projects, including pertinent information and identification of the Owners, must be submitted with the Bid.

2. See Article 18 – AWARD OF CONTRACT herein for additional requirements after opening of bids.

1.04 EXAMINATION OF CONTRACT DOCUMENTS AND SITE

A. It is the responsibility of each Bidder before submitting a Bid, to (a) examine the Contract Documents thoroughly, (b) visit the site to become familiar with local conditions that may affect cost, progress, performance or furnishing of the Work, (c) consider Federal, State and local Laws and Regulations that may affect cost, progress, performance or furnishing of the Work, (d) study and carefully correlate Bidder's observations with the Contract Documents, and (e) notify Engineer of all conflicts, errors or discrepancies in the Contract Documents.

1. Determine that the Bidding Documents are generally sufficient to indicate and convey understanding of all terms and conditions for the performance of the Work.

2. Become aware of the general nature of the work to be performed by Owner and others at the Site that relates to the Work as indicated in the Bidding Documents.

B. A geotechnical report for the project is available from the Engineer upon request.

C. Information and data reflected in the Contract Documents with respect to Underground Facilities at or contiguous to the site is based upon information and data furnished to the Owner by owners of such Underground Facilities or others, and Owner does not assume responsibility for the accuracy or completeness thereof, unless it is expressly provided otherwise in the Supplementary Conditions.

D. Provisions concerning responsibilities for the adequacy of data furnished to the prospective Bidders on subsurface conditions, Underground Facilities and other physical conditions, and possible changes in the Contract Documents due to differing conditions appear in Paragraph 4.02 and 4.03 of the General Conditions.

E. Before submitting a Bid, each Bidder will be responsible to make or obtain such explorations, tests and data concerning physical conditions (surface, subsurface and Underground Facilities) at or contiguous to the site or otherwise, which may affect cost, progress, performance or furnishing the Work in accordance with the time, price and other terms and conditions of the Contract Documents.

F. On request in advance, Owner will provide each Bidder access to the site to conduct such explorations and tests as each Bidder deems necessary for submission of a Bid. Bidder shall fill all holes, clean up and restore the site to its former condition upon completion of such explorations. A representative of the Owner shall be present during all tests.

G. The lands upon which the Work is to be performed, rights of way and easements for access thereto and other lands designated for use by Contractor in performing the Work are identified in the Contract Documents. All additional lands and access thereto required for temporary construction facilities or storage of materials and equipment are to be provided by Contractor. Easements for permanent structures or permanent changes in existing structures are to be obtained and paid for by Owner otherwise provided in the Contract Documents.

H. Reference is made to the Supplementary Conditions for the identification of the general nature of work that is to be performed at the site by Owner or others (such as utilities and other prime contractors) that relates to the work for which a Bid is to be submitted. On request, Owner will provide to each Bidder for examination access to or copies of Contract Documents (other than portions thereof related to price) for such work.

I. 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 area 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.

J. The provisions of 4.1 through 4.8, inclusive, do not apply to Asbestos, Polychlorinated Biphenyls (PCBs), Petroleum, Hazardous Waste or Radioactive Material covered by paragraph 4.06 of the General Conditions.

1.05 INTERPRETATIONS AND ADDENDA

A. All questions about the meaning or intent of the Contract Documents are to be directed in writing to Engineer. 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 three (3) days prior to the date for opening of Bids may not be answered. Only questions answered by formal, written Addenda will be binding. Oral and other interpretations or clarifications will be without legal effect.

B. Prior to the deadline for receiving Bids, Addenda may also be issued to modify the Bidding Documents as deemed advisable by Owner or Engineer.

1.06 BID SECURITY

A. Each Bid must be accompanied by Bid security made payable to Owner in an amount of five percent (5%) of the Bidder's maximum Bid price and in the form of a certified or bank check or a Bid Bond (on form attached, if a form is prescribed), issued by a surety.

B. The Bid security of the Successful Bidder will be retained until Bidder has executed the Agreement and furnished the required Contract security, whereupon the Bid security will be returned. If the successful Bidder fails to execute and deliver the Agreement and furnish the required Contract security within ten (10) days after the Notice of Award, Owner may annul

the Notice of Award, and the Bid security of that Bidder will be forfeited. The Bid security of other Bidders whom Owner believes to have a reasonable chance of receiving the award may be retained by Owner until the earlier of the seventh (7th) day after the Effective Date of the Agreement or the sixty-first (61st) day after the Bid opening, whereupon Bid security furnished by such Bidders will be returned. Bid security with Bids which are not competitive will be returned within seven (7) days after the Bid opening.

1.07 CONTRACT TIME

A. The number of days within which the Work is to be substantially completed, and also completed and ready for final payment (the Contract Time) is set forth in the Agreement and these Contract Documents. Special attention is drawn to the required early completion date for the relocation of the plant's primary electrical service line and natural gas service connection.

1.08 LIQUIDATED DAMAGES

A. Provisions for liquidated damages, if any, are set forth in Agreement.

1.09 SUBSTITUTE OR "OR EQUAL" ITEMS

A. The Contract, if awarded, will be on the basis of materials and equipment described in the Drawings or specified in the Specifications without consideration of possible substitutes or "or-equal" items of material or equipment that may be furnished or used by the Contractor if acceptable to the Engineer. The application for such acceptance will not be considered by the Engineer until after the Effective Date of the Agreement. The procedure for submission of any such application by the Contractor and consideration by the Engineer is set forth in Paragraph 6.05 of the General Conditions and may be supplemented in the General Requirements.

1.10 INDIRECT COSTS

A. All applicable sales, use, compensating, or other taxes to be paid or withheld by Bidder, now imposed by any taxing authority, on Equipment and Materials to be incorporated in the Work, and on any or all other cost items entering into the Contract Price, shall be included in the Bid price.

B. The Bidder shall include all such taxes except those on Equipment, Materials, if any, furnished by the Owner or others, (or exempted by the State) and shall furnish taxing authorities any information or reports pertaining thereto as required.

C. Owner is not exempt by law from taxes.

D. The cost of all construction licenses, building and other permits, and governmental inspections required by public authorities for performing the Work, which are applicable at the time Bids are opened and which are not specified to be obtained by Owner, shall be included in the Bid price.

E. The cost of all royalties and license fees on Equipment and Materials to be furnished and incorporated in the Work shall be included in the Bid price.

F. An allowance for the costs of initial tests, inspections, and related activities called for throughout the Bid Documents is included on the Bid Form. Contractor will be responsible for the costs associated with failed tests.

G. The cost of all electrical, water, gas, telephone, sanitary, and similar facilities and services required by the Contractor in performing the Work shall be included in the Bid Price unless specified otherwise.

1.11 SUBCONTRACTORS, SUPPLIERS AND OTHERS

A. If the Supplementary Conditions require the identity of certain Subcontractors, Suppliers and other persons and organizations (including those who are to furnish the principal items of material and equipment) to be submitted to Owner in advance of a specified date prior to the Effective Date of the Agreement, apparent Successful Bidder, and any other Bidder so requested, shall within five (5) working days after Bid opening submit to Owner a list of all such Subcontractors, Suppliers and other persons and organizations 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, person or organization if requested by Owner. An Owner or Engineer who after due investigation has reasonable objection to any proposed Subcontractor, Supplier, other person or organization, may before the Notice of Award is given request apparent Successful Bidder to submit an acceptable substitute without an increase in Bid price.

B. If apparent Successful Bidder declines to make any such substitution, Owner may award the contract to the next lowest Bidder that proposes to use acceptable Subcontractors, Suppliers and other persons and organizations. The declining to make requested substitutions will not constitute grounds for sacrificing the Bid security of any Bidder. Any Subcontractor, Supplier, other person or organization listed and to whom Owner or Engineer does not make 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.B of the General Conditions.

C. No Contractor shall be required to employ any Subcontractor, Supplier, other person or organization against whom Contractor has reasonable objection.

D. Trade (including, but not necessarily limited to electrical, plumbing and mechanical) permits are required for the respective subcontractors to obtain City inspection.

1.12 BID FORM

A. The Bid Form is included with the Bidding Documents.

B. All blanks on the Bid Form must be completed in ink or by typewriter. Erasures and alterations must be initialed and dated by the signer in ink.

C. Unit prices and lump sum amounts shall be shown in both words and figures. In case of discrepancy, the amount shown in words will govern and the unit price will govern over the extended amount.

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D. Bids by corporations must be executed in the corporate name by the president or a vice president (or other corporate officer accompanied by evidence of authority to sign) and the corporate seal must be affixed and attested by the secretary or an assistance secretary. The corporate address and state of incorporation must be shown below the signature.

E. Bids by partnerships must be executed in the partnership name and signed by a partner, whose title must appear under the signature and the official address of the partnership must be shown below the signature.

F. All names must be typed or printed below the signature.

G. The Bid shall contain an acknowledgment of receipt of all Addenda (the numbers of which must be filled in on the Bid Form).

H. The address, telephone number, and fax number if applicable for communications regarding the Bid must be shown.

I. 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.

J. A Bid by an individual shall show the Bidder's name and official address.

K. A Bid by a joint venture shall be executed by each joint venture in the manner indicated on the Bid Form. The official address of the joint venture must be shown below the signature.

1.13 SUBMISSION OF BIDS

A. Bids shall be submitted at or before the time and at the place indicated in the Advertisement for Bids and shall be submitted in a manila bid envelope. Any Bids received after the above time will not be accepted under any circumstances. Any uncertainty regarding the time a Bid is received will be resolved against the Bidder. The envelope shall be marked on the exterior **"CITY CORPORATION – RUSSELLVILLE – POLLUTION CONTROL WORKS IMPROVEMENTS"** and with the name and address of the Bidder and accompanied by the Bid Security and other required documents. The envelope containing the Bid documents shall bear the Bidder's Arkansas contractor's license number. If the Bid is sent through the mail or other delivery system, the sealed envelope shall be enclosed in a separate envelope with the notation "SEALED BID ENVELOPE ENCLOSED" on the face thereof.

B. The bids shall be submitted in two opaque envelopes, one within the other. The outside envelope shall contain all documents which will deem the Bid responsive. The second inner envelope shall be contained and sealed within the outer envelope and shall contain only the Bidder's Bid Amount (00300 Article 4.1) included in the Bid Form.

C. Bid Proposal: Bids shall be received from Bidders only on the Bid Form in the Bidding Documents which are issued to him in his name. A single bid shall be submitted for all portions of the Contract Work.

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1.14 MODIFICATION AND WITHDRAWAL OF BIDS

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

B. If, within twenty-four (24) hours after Bids are opened, any Bidder files a duly-signed, written notice with the Owner and promptly thereafter demonstrates to the reasonable satisfaction of Owner that there was a material and substantial mistake in the preparation of its Bids, that Bidder may withdraw its Bid and the Bid security will be returned. Thereafter, that Bidder will be disqualified from further bidding on the Work to be provided under the Contract Documents.

1.15 OPENING OF BIDS

A. Bids will be opened and (unless obviously non-responsive) read aloud publicly. The Bid documents provided to the Contractor will be reviewed and evaluated to determine that the bid is responsive.

B. After the Bid is deemed responsive, the separate envelope containing the Bidder's Bid Amount (00300 – Article 4) will be opened and the total amount written in words read aloud.

C. If the Bid documents are determined unresponsive the separate envelope containing the Bidder's Bid Amount (00300 – Article 4) will remained sealed and all Bid documents will be returned to the Bidder.

1.16 BIDS TO REMAIN SUBJECT TO ACCEPTANCE

A. All Bids will remain subject to acceptance for sixty (60) days after the day of the Bid opening, but Owner may, in its sole discretion, release any Bid and return the Bid security prior to that date.

B. Extensions of time when Bids shall remain open beyond the sixty-day period may be made only by mutual agreement between the Owner, the apparent successful Bidder, and the surety for the apparent successful Bidder.

1.17 BID PROTEST

A. Any protest of a bid specification must be made in writing and received by the Owner no later than three (3) days before the bid opening date.

B. Any protest of bid award must be made in writing and received by the Owner no later than three (3) days after notice of intent to award has been made. Additionally, if the subject contract requires board of directors approval, written protest must be received by the contracting authority no later than five (5) days before the next board of directors meeting at which the recommended bid award will be considered.

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1.18 AWARD OF CONTRACT

A. Owner reserves the right to reject any and all Bids, to waive any and all informalities and to negotiate Contract terms with the Successful Bidder, and the right to disregard all nonconforming, nonresponsive, unbalanced or conditional Bids. Also, Owner reserves the right to 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, whether because the Bid is not responsive or the Bidder is unqualified or of doubtful financial ability or fails to meet any other pertinent standard or criteria established by Owner. Discrepancies in the multiplication of units of Work and unit prices will be resolved in favor of the unit prices. Discrepancies between the indicated sum of any column of figures and the correct sum thereof will be resolved in favor of the correct sum.

B. In evaluating Bids, Owner will consider the qualifications of the Bidders, whether or not the Bids comply with the prescribed requirements, and such alternates, unit prices and other data, as may be requested in the Bid Form or prior to the Notice of Award. Owner may accept any such alternatives in any order or combination, whether in the order in which they are listed in the Bid Form or not.

C. Owner may consider the qualifications and experience of Subcontractors, Suppliers, and other persons and organizations proposed for those portions of the Work as to which the identity of Subcontractors, Suppliers, and other persons and organizations must be submitted as provided in the Supplementary Conditions. Owner also may consider the operating costs, maintenance requirements, performance data and guarantees of major items of materials and equipment proposed for incorporation in the Work when such data is required to be submitted prior to the Notice of Award.

D. Owner may conduct such investigations as Owner deems necessary to assist in the evaluation of any Bid and to establish the responsibility, qualifications and financial ability of Bidders, proposed Subcontractors, Suppliers and other persons and organizations to perform and furnish the Work in accordance with the Contract Documents to Owner's satisfaction within the prescribed time.

E. If the Contract is to be awarded, it will be awarded to the lowest Bidder whose evaluation by Owner indicates to Owner that the award will be in the best interest of the Project.

F. If the Contract is to be awarded, Owner will give the successful Bidder a Notice of Award within sixty (60) days after the day of the Bid opening.

G. Attention of Bidders is directed to Supplementary Conditions, included in these documents for provisions concerning scope of work, completion time, availability of plans, specifications and other documents, payment and similar subjects.

1.19 CONTRACT SECURITY

A. The General Conditions and the Supplementary Conditions set forth Owner's requirements as to performance and payment Bonds and a Warranty Bond. When the successful Bidder delivers the executed Agreement to Owner, it must be accompanied by the required performance and payment Bonds. At the time of Final Acceptance, the Contractor shall provide the Owner the Warranty Bond.

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PART 2: PRODUCTS

2.01 SIGNING OF AGREEMENT

A. When Owner gives a Notice of Award to the successful Bidder, it will be accompanied by the required number of unsigned counterparts of the Agreement and all other written Contract Documents attached. Within ten (10) days thereafter Contractor shall sign and deliver the required number of counterparts of the Agreement and attached documents to Owner with the required Bonds. Within ten (10) days thereafter, Owner shall deliver one fully-signed counterpart to Contractor. Each counterpart is to be accompanied by a complete set of the Drawings with appropriate identification.

2.02 PRE-BID CONFERENCE

A. A non-mandatory pre-bid conference will be held at the time and date stated in the Invitation to Bid at the **Pollution Control Works Administration Building, 404 Jimmy Lile RD, Russellville, Arkansas 72802.**

B. Representatives of Owner and Engineer will be present to discuss the Project. Bidders are encouraged to attend and participate in the conference. Engineer will transmit to all prospective Bids of record such Addenda as Engineer considers necessary in response to questions arising at the conference. Bidders are reminded that any representations or understandings arising from any such Pre-bid Conference shall not supersede the written provision of the Contract Documents themselves.

2.03 RETAINAGE

A. Provisions concerning retainage are set forth in the Agreement, General Contract, and Supplemental Conditions.

2.04 SPECIAL LEGAL REQUIREMENTS

A. Attention of Bidders is called to Act 150, Acts of Arkansas 1965, concerning the licensing of contractors to do business in Arkansas.

B. It is conclusively presumed that Bidders have familiarized themselves with Arkansas laws which may be applied to a Contract for the Work proposed herein as the aforementioned Acts are not exclusive. It is further conclusively presumed that Bidders have familiarized themselves with Federal and local laws, ordinances and regulations pertaining to the Work proposed herein.

PART 3: EXECUTION (NOT USED)

END OF SECTION

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SECTION 00300

BID FORM

Project Name: Pollution Control Works Schedule II – Nitrate Removal

BID TO
Owner: City Corporation
Russellville, AR
205 West 3rd Place
Russellville, Arkansas 72801

BID FROM
Bidder: _____
_____
_____
_____

ARTICLE 1. The undersigned Bidder proposes and agrees, if this Bid is accepted, to enter into an agreement with Owner in the Form included in the Contract Documents to perform and furnish all Work as specified or indicated in the Contract Documents for the Bid price and within the Bid time indicated in this Bid and in accordance with the other terms and conditions of the Contract Documents.

ARTICLE 2. Bidder accepts all of the terms and conditions of the Invitation to Bid and Instructions to Bidders, including without limitation those dealing with the disposition of Bid security. This Bid will remain subject to acceptance for 60 days after the day of Bid opening. Bidder will sign and deliver the required number of counterparts of the Agreement with the Bonds and other documents required by the Bidding Requirements within 10 days after the date of Owner's Notice of Award.

ARTICLE 3. In submitting this Bid, Bidder represents, as more fully set forth in the Agreement, that:

3.1 Bidder has examined and carefully studied the Bidding Documents, and the following Addenda, receipt of all which is hereby acknowledged:

| Number | Date | Reviewer's Signature |
|---|---|---|
| _____ | _____ | _____ |
| _____ | _____ | _____ |
| _____ | _____ | _____ |
| _____ | _____ | _____ |

3.2 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, performance, and furnishing of the Work.

3.3 Bidder is familiar with and is satisfied as to all federal, state, and local Laws and Regulations that may affect cost, progress, performance, and furnishing of the Work.

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3.4 Bidder has carefully studied all reports of explorations and tests of subsurface conditions at or contiguous to the site and all drawings of physical conditions in or relating to existing surface or subsurface structures at or contiguous to the site. Bidder acknowledges that such reports and drawings are not Contract Documents and may not be complete for Bidder's purposes. Bidder acknowledges that Owner and Engineer do not assume responsibility for the accuracy or completeness of information and data shown or indicated in the Bidding Documents with respect to underground facilities at or contiguous to the site. Bidder has obtained and carefully studied (or assumes responsibility for having done so) all such additional or supplementary examinations, investigations, explorations, tests, studies, and data concerning conditions (surface, subsurface, and underground facilities) at or contiguous to the site or otherwise which may affect cost, progress, performance, or finishing of the Work or which relate to any aspect of the means, methods, techniques, sequences, and procedures of construction to be employed by Bidder and safety precautions and programs incident thereto. Bidder does not consider that any additional examinations, investigations, explorations, tests, studies, or data are necessary for the determination of this Bid for performance, and furnishing of the Work in accordance with the times, price and other terms and conditions of the Contract Documents.

3.5 Bidder is aware of the general nature of Work to be performed by Owner and others at the site that relates to Work for which this Bid is submitted as indicated in the Contract Documents.

3.6 Bidder has correlated the information known to Bidder, 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.

3.7 Bidder has given Engineer written notice of all conflicts, errors, ambiguities, or discrepancies that Bidder has discovered in the Contract Documents and the written resolution thereof by Engineer is acceptable to Bidder, and the Contract Documents are generally sufficient to indicate and convey understanding of all terms and conditions for performing and furnishing the Work for which this Bid is submitted.

3.8 This Bid is genuine and not made in the interest of or on behalf of any undisclosed person, firm, or corporation and is not submitted in conformity with any agreement or rules of any group, association, organization, or corporation; Bidder has not directly or indirectly induced or solicited any other Bidder to submit a false or sham Bid; Bidder has not solicited or induced any person, firm, or a corporation to refrain from bidding; and bidder has not sought by collusion to obtain for himself any advantage over any other Bidder or over Owner.

ARTICLE 4. Bidder will complete the Work in accordance with the Contract Documents for the following price(s):

4.1 BIDDERS BID AMOUNT

**Item A** - Construction of Pollution Control Works Schedule II – Nitrate Removal (as shown in the Plans and stated in the Specifications, except for Items B & C).

Lump Sum Bid: _____

_____ dollars

($ _____)

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**Item B** - Trench and/or Excavation Safety Systems

Cost for Trench and Excavation Safety Systems (Specification 01665): In compliance with Act 291 of the General Assembly of the State of Arkansas requiring the inclusion in all bids for public works projects a separate pay item for trench and/or excavation safety systems:

Lump Sum Bid: _____

_____ dollars

($_____)

**Item C** – Allowance for Quality Control Testing

Allowance for quality control testing of construction materials as outlined in Specification 01450:

Total Allowance: Twenty Thousand Dollars Even ($20,000.00)

**Total Lump Sum Bid (Items A through C)**

Lump Sum Bid: _____

_____ dollars

($_____)

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4.2 PROPOSED SUBCONTRACTORS: The following information gives the name, business address, and portion of work (description and dollar amount of work to be done) for each subcontractor that will be used in the work if the bidder is awarded the contract. No subcontractor doing work in excess of 5 percent of the total amount of the bid who is not listed below shall be used without the written approval of the Owner.

The Bidder shall also list below the proposed subcontractor(s) that will be responsible for the installation of the dechlorination system equipment, piping, and appurtenances, and the emergency valve closure system.

Additional supporting data may be attached to this page. Each page shall be sequentially numbered and headed [Proposed Subcontractors] and shall be signed.

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| Firm Name | Arkansas Contractor's License Number | Business Address | Description of Work | Dollar Amount of Subcontract |
|---|---|---|---|---|
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
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ARTICLE 5. Bidder agrees that the Work will be completed within the following times:

5.1 The Contractor shall be Substantially Completed with the Work within 540 calendar days after the date when the Notice to Proceed is issued, and completed and Ready for Final Payment within 30 calendar days after Substantial Completion in accordance with Article 14 of the General Conditions. The project shall be completed and ready for final payment within 570 calendar days after the date when the Contract Time commences to run.

5.2 Bidder accepts the provisions of the Agreement as to Liquidated Damages in the event of failure to complete the Work within the times specified in the Agreement.

ARTICLE 6. The following documents are attached to and made a condition of this Bid:

6.1 Bid Form (Section 00300)

6.2 Required bid security in the form of a certified check or a Bid Bond and in the amount of 5% of total Bid price.

6.3 Non-collusion Affidavit (Section 00480)

6.4 A list of comparable projects, including pertinent information and identification of the owners as described in Section 00100 ARTICLE 3, Section 3.3.1, Page 00100-2.

ARTICLE 7. Communications concerning this Bid shall be addressed to:

Mr. Matt Crow, P.E.
CDM Smith Inc.
8140 Walnut Hill Lane, Suite 1000
Dallas, TX 75231
Phone No. 214-346-2800
Fax No. 214-987-2017
E-mail: crowjm@cdmsmith.com

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ARTICLE 8. The terms used in this Bid which are defined in the GENERAL CONDITIONS or Instructions to Bidders, will have the meanings assigned to them.

**Bidder** submitting this **Bid** is:

☐ A Corporation, incorporated in the State of _____

☐ A Partnership, consisting of the following partners, whose full names are: _____

_____

_____

☐ A Limited Liability Company doing business as: _____

☐ An Individual whose full name is: _____

SUBMITTED on _____, 2013 _____
(Name of Bidder)

Approved By _____ By _____
(Authorized Signature) (Title)

Attested By _____ _____
(Authorized Signature) (Address)

Seal
(If a Corporation)

_____
(City and State)

_____
(Telephone Number)

_____
(Facsimile Number)

END OF SECTION

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SECTION 00410

BID BOND

KNOW ALL MEN BY THESE PRESENTS, that we, the undersigned, _____ as Principal, and _____ as Surety, are hereby held and firmly bound unto the City Corporation, hereinafter called the Owner in the penal sum of _____

_____

for payment of which, well and truly to be made, we hereby jointly and severally bind ourselves, successors and assigns.

The Condition of the above obligation is such that whereas the Principal has submitted to the Owner a certain Bid, attached hereto and hereby made a part hereof to enter into a contract in writing, for Pollution Control Works Schedule II – Nitrate Removal.

NOW, THEREFORE,

(a) If said Bid shall be rejected, or

(b) If said Bid shall be accepted and the Principal shall execute and deliver a contract in the Form of Contract attached hereto (properly completed in accordance with said Bid) and shall furnish a Bond for his faithful performance of said contract, and for the payment of all persons performing labor or furnishing materials in connection therewith, and shall in all other respects perform the agreement created by the acceptance of said Bid, then this obligation shall be void, otherwise the same shall remain in force and effect; it being expressly understood and agreed that the liability of the Surety for any and all claims hereunder shall, in no event, exceed the penal amount of this obligation as herein stated.

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IN WITNESS WHEREOF, the Principal and the Surety have hereunto set their hands and seals, and such of them as are corporations have caused their corporate seals to be hereto affixed and these presents to be signed by their proper officers, the day and year first set forth above.

Signed, this _____ day of_____ 2013.

_____

(Principal)

_____

(Surety)

By:_____

END OF SECTION

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SECTION 00480

NON-COLLUSION AFFIDAVIT

STATE OF Arkansas §
§
COUNTY OF Pope §

_____, of lawful age, being first duly sworn, says that (he/she) is the agent authorized by the Bidder to submit the attached Bid.

Affiant further states that the Bidder has not been a party to any collusion among Bidders in the restraint of freedom of competition by agreement to bid at a fixed price or to refrain from bidding; or with any equipment supplier by manipulating the sales price of any item(s) to give advantage to a particular Contractor, or with any official or employee of the Owner as to quantity, quality, or price in the prospective Contract, or any other terms of said prospective Contract; or, in any discussion between Bidders and any official of the Owner concerning exchange of money or other thing of value for special consideration in the letting of a Contract.

Bidder

SUBSCRIBED AND SWORN TO BEFORE ME, this _____ day of _____, 2013.

Notary Public

My Commission Expires:

_____

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SECTION 00500

AGREEMENT BETWEEN
OWNER AND CONTRACTOR

THIS AGREEMENT is dated as of the_____ day of _____ in the year 2013 by and between CITY COPORATION (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

1.1 The Contractor shall commence and complete all Work for the Pollution Control Works Plant Schedule II – Nitrate Removal, as specified or indicated in the Contract Documents. The Work is generally described as follows:

*The project includes a new distribution structures, anaerobic basins, secondary clarifiers, RAS/WAS pump station, electrical building, site work, and other ancillary items. Contractor shall provide all of the equipment, labor, and appurtenances necessary to complete the work.*

1.2 The Contractor shall furnish all materials, supplies, tools, equipment, labor and other service necessary for the completion of the Work described herein.

1.3 The Contractor shall commence the Work required by the Contract Documents on or before a date to be specified in the Notice to Proceed and completed and ready for final payment as specified in the Bid Form. The Contractor shall pay the Owner, as liquidated damages, the sum as specified below for each calendar day thereafter that the Work is not complete.

1.4 The Contractor agrees to perform all of the Work described in the Contract Documents and comply with the terms therein as shown in the Bid Proposal.

ARTICLE 2. ENGINEER

The Project has been designed by CDM Smith, Inc. who is hereinafter called Engineer and who will assume all duties and responsibilities and have the rights and authority assigned to Engineer in the Contract Documents in connection with completion of the Work in accordance with the Contract Documents.

ARTICLE 3. CONTRACT TIME

3.1 The Contractor shall substantially complete the Work within two hundred and seventy (270) calendar days and after the date when the Contract Time commences to run as provided in

Paragraph 2.03 of the General Conditions of the Construction Contract (General Conditions), complete and ready for final acceptance in accordance with Article 14 of the General Conditions within three hundred (300) calendar days after the date when the Contract Time commences to run.

3.2 Liquidated Damages – Owner and Contractor recognize that the Owner will suffer direct financial loss if Work is not completed within the Contract times specified in Paragraph 3.1 above plus any extensions thereof allowed in accordance with Article 12 of the General Conditions, and therefore time is of the essence. They also recognize the delays, expense, and difficulties involved in proving in a legal proceeding the actual loss suffered by Owner if the Work is not completed on time. Accordingly, instead of requiring any such proof, Contactor and Surety agree to forfeit and pay owner as liquidated damages for delay (but not as a penalty) the amount of one thousand dollars ($1,000) for each calendar day that expires after the Contract Time specified in Paragraph 3.1 for substantial completion until the Work is substantially complete and five hundred dollars ($500) for each calendar day that expires after the time specified in Paragraph 3.1 for final completion and ready for final acceptance until the Work is completed. These amounts represent a reasonable estimate of Owner's expenses for extended delays and for inspection, engineering services, and administrative costs associated with such delay. This provision shall be effective between the parties ipso facto and without demand or putting in default, it being specifically agreed that the Contractor by his mere failure to complete the Work on or before the date specified shall be deemed in default.

ARTICLE 4. CONTRACT DOCUMENTS

4.1 The following Contract Documents, which comprise the entire Agreement between Owner and Contractor, are all hereby made a part of that Agreement to the same extent as if incorporated herein in full:

- 4.1 Seals
- 4.2 Invitation to Bid
- 4.3 Information for Bidders
- 4.4 Bid Form
- 4.6 Bid Bond
- 4.7 Non-collusion Affidavit
- 4.9 Agreement Between Owner and Contractor
- 4.10 Arkansas Statutory Performance and Payment Bond
- 4.11 General Conditions

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4.12 Supplementary Conditions

4.13 Prevailing Wage Rates

4.14 Notice of Award

4.15 Notice to Proceed

4.16 Specifications bearing the project title "City Corporation – Schedule II – Nitrate Removal"

4.17 Drawings as listed on Drawing G2

4.18 Addenda (to be issued if necessary)

4.19 Change Orders (to be issued if necessary)

ARTICLE 5. CONTRACT PRICE

CONTACT PRICE: The amount to be paid to the Contractor by the Owner for completion of all work hereunder is a lump sum of:_____

_____

($_____)

Contract price is firm and subject only to modification by written change order agreed to by both parties.

ARTICLE 6. PAYMENT

Contractor shall submit Applications for Payment in accordance with Article 14 of the General Conditions. Applications for Payment will be processed by the Engineer as provided in the General Conditions.

6.1 The Owner shall pay the Contractor in the manner and at such times as set forth in the General Conditions such amounts as required by the Contract Documents.

6.2 Progress payments will be based upon estimated quantities of completed contract unit price items or upon estimated percentages of completion of the schedule of lump sum values of labor and materials incorporated into the Work on the last day of each month or other mutually agreed regular monthly date ending the progress payment period.

6.3 Retainage will be withheld at a rate of ten percent (10%) of the total amount of completed Work up to the point that the Engineer certifies that the project is 50% complete. Additional retainage on completed work will not be withheld thereafter. Retainage will not be withheld on materials that are properly stored and protected on the project site.

6.4 Upon final completion of all Work, the Contractor may request a final inspection and may make a final Application for Payment as provided by Paragraph 14.12 of the General Conditions, upon the Owner's certificate of final acceptance.

ARTICLE 7. CONTRACTOR'S REPRESENTATIONS

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

7.1 Contractor has familiarized itself with the nature and extent of the Contract Documents, Work, site, locality, and all local conditions, laws and regulations that in any manner may affect cost, progress, performance, or finishing of the Work.

7.2 Contractor has studied carefully all reports of explorations and tests of subsurface physical conditions and drawings of physical conditions which are identified in the Information Available to Bidders and as provided in the General Conditions.

7.3 Contractor has obtained and carefully studied (or assumed responsibility for obtaining and carefully studying) all such examinations, investigations, explorations, tests, reports, and studies (in addition to or to supplement those referred to in Paragraph 7.2 above) which pertain to the subsurface or physical conditions at or contiguous to the site or which otherwise may affect the cost, progress, performance, or furnishing of the Work as Contractor considers necessary for the performance or furnishing of the Work at the Contract Price, within the Contract Time and in accordance with the other terms and conditions of the Contact Documents, including specifically the provisions of Paragraph 4.02 of the General Conditions. In exercising its responsibility with respect to subsurface conditions and physical conditions at the site, Contactor has or will obtain or perform at no additional cost to the Owner such additional examinations, investigations, explorations, tests, reports, studies, or similar information or data as my be required by Contractor for such purposes.

ARTICLE 8. MISCELLANEOUS

8.1 No assignment by a party hereto of any rights under or interests in the Contract Documents will be binding on another party hereto without the written consent of the party sought to be bound; and specifically but without limitations, 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. Notwithstanding the foregoing, the Owner may assign this

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contract to the State of Arkansas or any political subdivision, municipality, special district, or authority thereof without Contractor's consent and without recourse.

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

8.3 It is hereby agreed and understood by the parties hereto that any and all disputes that may result in litigation shall be litigated in the Circuit Court of Pope County, Arkansas.

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IN WITNESS WHEREOF, Owner and Contractor have executed, or caused to be executed by their duly authorized officials, this Agreement in three (3) counterparts, each of which shall be deemed as an original.

OWNER

City Corporation

PRINTED NAME:

_____

BY _____

(Signature)

CONTRACTOR

_____

PRINTED NAME:

_____

BY_____

(Signature)

[CORPORATE SEAL]

ATTEST_____

Address for giving notices:

205 West 3rd Place

Russellville, AR 72801

ATTEST_____

Address for giving notices:

_____

_____

_____

License No._____

(If Contractor is a corporation, attach evidence of authority to sign.)

END OF SECTION 00500

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SECTION 00600

ARKANSAS STATUTORY PERFORMANCE AND PAYMENT BOND

We,_____as Principal, hereinafter called Principal, and _____as Surety, hereinafter called the Surety, are held and firmly bound unto the City Corporation hereinafter called "Owner" in the amount of _____and no Cents ($ ) for the payment where of Principal and Surety bind themselves, their heirs, personal representatives, and successors, and assigns, jointly and severally, and firmly by these presents.

Principal has by written agreement dated _____ entered into a contract with Owner for POLLUTION CONTROL WORKS SCHEDULE II – NITRATE REMOVAL, which contract is by reference made a part hereof, and is hereinafter referred to as the Contract.

The condition of this obligation is such that if the Principal shall faithfully perform the Contract on his part and shall fully indemnify and save harmless the Owner from all cost and damage which he may suffer by reason of failure so to do and shall fully reimburse and repay the Owner all outlay and expense which the Owner may incur in making good any such default, and, further, that if the Principal shall pay all persons all indebtedness for labor or materials furnished or performed under said contract failing which such persons shall have a direct right of action against the Principal and Surety jointly and severally under this obligation, subject to the Owner's priority, then this obligation shall be null and void; otherwise it shall remain in full force and effect.

No suit, action or proceeding shall be brought on this bond outside the State of Arkansas. No suit, action or proceeding shall be brought on this bond except by the Owner after six months from the date final payment is made on the Contract, not shall any suit, action or proceeding be brought by the Owner after two years from the date on which the final payment under the Contract falls due. Any Alterations which may be made in the terms of the contract or in the work to be done under it, or the giving by the Owner of any extension of time for the performance of the Contract, or any other forbearance on the part either of the Owner or Principal to the other shall not in any way release the Principal and the Surety or Sureties, or either or any of them, their heirs, personal representatives, successors, or assigns from their liability

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hereunder, notice to the Surety of Sureties of any such alteration, extension, or forbearance being hereby waived.

In no event shall the aggregate liability of the Surety exceed the sum set herein.

Executed on the _____day of _____2013.

By _____

_____(Seal)
Principal

Witness: )
)
Attest: )

_____

_____

_____(Seal)
Surety

This Bond is given in Compliance with Act 351 of 1953, as amended.
If Contractor is partnership, all partners should execute bond. This bond must be filed by the Principal or Surety with the Circuit Court in the county where work is to be performed and proof of filing provided to Owner, prior to start of construction.

END OF SECTION

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

# STANDARD GENERAL CONDITIONS OF THE CONSTRUCTION CONTRACT

Prepared by

**ENGINEERS JOINT CONTRACT DOCUMENTS COMMITTEE**

and

Issued and Published Jointly by

ACEC
American Council of Engineering Companies

ASCE American Society of Civil Engineers

National Society of Professional Engineers
Professional Engineers in Private Practice

AMERICAN COUNCIL OF ENGINEERING COMPANIES

ASSOCIATED GENERAL CONTRACTORS OF AMERICA

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*A Practice Division of the*
NATIONAL SOCIETY OF PROFESSIONAL ENGINEERS

Endorsed by

CONSTRUCTION SPECIFICATIONS INSTITUTE

These General Conditions have been prepared for use with the Suggested Forms of Agreement Between Owner and Contractor (EJCDC C-520 or C-525, 2007 Editions). Their provisions are interrelated and a change in one may necessitate a change in the other. Comments concerning their usage are contained in the Narrative Guide to the EJCDC Construction Documents (EJCDC C-001, 2007 Edition). For guidance in the preparation of Supplementary Conditions, see Guide to the Preparation of Supplementary Conditions (EJCDC C-800, 2007 Edition).


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STANDARD GENERAL CONDITIONS OF THE
CONSTRUCTION CONTRACT

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## ARTICLE 1 – DEFINITIONS AND TERMINOLOGY

1.01 *Defined Terms*

A. Wherever used in the Bidding Requirements or Contract Documents and printed with initial capital letters, the terms listed below will have the meanings indicated which are applicable to both the singular and plural thereof. In addition to terms specifically defined, terms with initial capital letters in the Contract Documents include references to identified articles and paragraphs, and the titles of other documents or forms.

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

2. *Agreement*—The written instrument 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. *Bidder*—The individual or entity who submits a Bid directly to Owner.

7. *Bidding Documents*—The Bidding Requirements and the proposed Contract Documents (including all Addenda).

8. *Bidding Requirements*—The advertisement or invitation to bid, Instructions to Bidders, Bid security of acceptable form, if any, and the Bid Form with any supplements.

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*—Those items so designated in the Agreement. Only printed or hard copies of the items listed in the Agreement are Contract Documents. Approved Shop Drawings, other Contractor submittals, and the reports and drawings of subsurface and physical conditions 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 Milestones, if any; (ii) achieve Substantial Completion; and (iii) 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 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


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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. *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.

21. *General Requirements*—Sections of Division 1 of the Specifications.

22. *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.

23. *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.

24. *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.

25. *Liens*—Charges, security interests, or encumbrances upon Project funds, real property, or personal property.

26. *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.

27. *Notice of Award*—The written notice by Owner to the Successful Bidder stating that upon timely compliance by the Successful Bidder with the conditions precedent listed therein, Owner will sign and deliver the Agreement.

28. *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.

29. *Owner*—The individual or entity with whom Contractor has entered into the Agreement and for whom the Work is to be performed.

30. *PCBs*—Polychlorinated biphenyls.

31. *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.

32. *Progress Schedule*—A schedule, prepared and maintained by Contractor, describing the sequence and duration of the activities comprising the Contractor's plan to accomplish the Work within the Contract Times.

33. *Project*—The total construction of which the Work to be performed under the Contract Documents may be the whole, or a part.

34. *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.

35. *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.

36. *Resident Project Representative*—The authorized representative of Engineer who may be assigned to the Site or any part thereof.

37. *Samples*—Physical examples of materials, equipment, or workmanship that are representative of some portion of the Work


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and which establish the standards by which such portion of the Work will be judged.

38. *Schedule of Submittals*—A schedule, prepared and maintained by Contractor, of required submittals and the time requirements to support scheduled performance of related construction activities.

39. *Schedule of Values*—A schedule, prepared and maintained by Contractor, allocating portions of the Contract Price to various portions of the Work and used as the basis for reviewing Contractor's Applications for Payment.

40. *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.

41. *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.

42. *Specifications*—That part of the Contract Documents consisting of written requirements for materials, equipment, systems, standards and workmanship as applied to the Work, and certain administrative requirements and procedural matters applicable thereto.

43. *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.

44. *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.

45. *Successful Bidder*—The Bidder submitting a responsive Bid to whom Owner makes an award.

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

47. *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 Subcontractor.

48. *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.

49. *Unit Price Work*—Work to be paid for on the basis of unit prices.

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

51. *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


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effect, if any, on the Contract Price or Contract Times.

1.02 *Terminology*

A. The words and terms discussed in Paragraph 1.02.B through F are not defined but, when used in the Bidding Requirements or Contract Documents, have the indicated meaning.

B. *Intent of Certain Terms or Adjectives:*

1. The Contract Documents include the terms "as allowed," "as approved," "as ordered," "as directed" or terms of like effect or import to authorize an exercise of professional judgment by Engineer. In addition, the adjectives "reasonable," "suitable," "acceptable," "proper," "satisfactory," or adjectives of like effect or import are used to describe an action or determination of Engineer as to the Work. It is intended that such exercise of professional judgment, action, or determination will be solely to evaluate, in general, the Work for compliance with the information in the Contract Documents and with the design concept of the Project as a functioning whole as shown or indicated in the Contract Documents (unless there is a specific statement indicating otherwise). The use of any such term or adjective is not intended to and shall not be effective to assign to Engineer any duty or authority to supervise or direct the performance of the Work, or any duty or authority to undertake responsibility contrary to the provisions of Paragraph 9.09 or any other provision of the Contract Documents.

C. *Day:*

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

D. *Defective:*

1. The word "defective," when modifying the word "Work," refers to Work that is unsatisfactory, faulty, or deficient in that it:

a. does not conform to the Contract Documents; or

b. does not meet the requirements of any applicable inspection, reference standard, test, or approval referred to in the Contract Documents; or

c. has been damaged prior to Engineer's recommendation of final payment (unless responsibility for the protection thereof has been assumed by Owner at Substantial Completion in accordance with Paragraph 14.04 or 14.05).

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

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

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

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

4. 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.

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

## ARTICLE 2 – PRELIMINARY MATTERS

2.01 *Delivery of Bonds and Evidence of Insurance*

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

B. *Evidence of Insurance:* Before any Work at the Site is started, Contractor and Owner shall each deliver to the other, with copies to each additional


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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.

2.02 *Copies of Documents*

A. Owner shall furnish to Contractor up to ten printed or hard copies of the Drawings and Project Manual. 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. *Preliminary Schedules:* Within 10 days after the Effective Date of the Agreement (unless otherwise specified in the General Requirements), Contractor shall submit to Engineer for timely review:

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

2. a preliminary Schedule of Submittals; and

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

2.06 *Preconstruction Conference; Designation of Authorized Representatives*

A. Before any Work at the Site is started, a conference attended by Owner, Contractor, Engineer, and others as appropriate will be held to establish a working understanding among the parties as to the Work and to discuss the schedules referred to in Paragraph 2.05.A, procedures for handling Shop Drawings and other submittals, processing Applications for Payment, and maintaining required records.

B. At this conference Owner and Contractor each shall designate, in writing, a specific individual to act as its authorized representative with respect to the services and responsibilities under the Contract. Such individuals shall have the authority to transmit instructions, receive information, render decisions relative to the Contract, and otherwise act on behalf of each respective party.

2.07 *Initial Acceptance of Schedules*

A. At least 10 days before submission of the first Application for Payment a conference attended by Contractor, Engineer, and others as appropriate will be held to review for acceptability to Engineer as provided below the schedules submitted in accordance with Paragraph 2.05.A. Contractor shall have an additional 10 days to make corrections and adjustments and to complete and resubmit the schedules. No progress payment shall be made to Contractor until acceptable schedules are submitted to Engineer.

1. The Progress Schedule will be acceptable to Engineer if it provides an orderly progression of the Work to completion within the Contract Times. Such acceptance will not impose on Engineer responsibility for the Progress Schedule, for sequencing, scheduling, or progress of the Work, nor interfere with or relieve Contractor from Contractor's full responsibility therefor.

2. Contractor's Schedule of Submittals will be acceptable to Engineer if it provides a


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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 required by one is as binding as if required by all.

B. It is the intent of the Contract Documents to describe a functionally complete project (or part thereof) to be constructed in accordance with the Contract Documents. Any labor, documentation, services, materials, or equipment that reasonably may be inferred from the Contract Documents or from prevailing custom or trade usage as being required to produce the indicated 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. No such provision or instruction shall be effective to assign to Owner, Engineer, or any of their officers, directors, members, partners, employees, agents, consultants, or subcontractors, any duty or authority to supervise or direct the performance of the Work or any duty or authority to undertake responsibility inconsistent with the provisions of the Contract Documents.

3.03 *Reporting and Resolving Discrepancies*

A. *Reporting Discrepancies:*

1. *Contractor's Review of Contract Documents Before Starting Work*: 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 discovers, or has actual knowledge of, and shall obtain a written interpretation or clarification from Engineer before proceeding with any Work affected thereby.

2. *Contractor's Review of Contract Documents During Performance of Work*: 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 (a) any applicable Law or Regulation , (b) any standard, specification, manual, or code, or (c) any instruction of any Supplier, then Contractor shall promptly report it to Engineer in writing. Contractor shall not proceed with the Work affected thereby (except in an emergency as required by Paragraph 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.

3. Contractor shall not be liable to Owner or Engineer for failure to report any conflict, error, ambiguity, or discrepancy in the Contract Documents unless Contractor had actual knowledge thereof.

B. *Resolving Discrepancies:*


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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, or code, or the instruction of any Supplier (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 by either a Change Order or 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:

   1. A Field Order;

   2. Engineer's approval of a Shop Drawing or Sample (subject to the provisions of Paragraph 6.17.D.3); or

   3. Engineer's written interpretation or clarification.

3.05 *Reuse of Documents*

A. Contractor and any Subcontractor or Supplier shall not:

   1. have or acquire any title to or ownership rights in any of the Drawings, Specifications, or other documents (or copies of any thereof) prepared by or bearing the seal of Engineer or its consultants, including electronic media editions; or

   2. reuse any such Drawings, Specifications, other documents, or copies thereof on extensions of the Project or any other project without written consent of Owner and Engineer and specific written verification or adaptation by Engineer.

B. The prohibitions of this Paragraph 3.05 will survive final payment, or termination of the Contract. Nothing herein shall preclude Contractor from retaining copies of the Contract Documents for record purposes.

3.06 *Electronic Data*

A. Unless otherwise stated in the Supplementary Conditions, the data furnished by Owner or Engineer to Contractor, or by Contractor to Owner or Engineer, that may be relied upon are limited to the printed copies (also known as hard copies). Files in electronic media format of text, data, graphics, or other types are furnished only for the convenience of the receiving party. Any conclusion or information obtained or derived from such electronic files will be at the user's sole risk. If there is a discrepancy between the electronic files and the hard copies, the hard copies govern.

B. Because data stored in electronic media format can deteriorate or be modified inadvertently or otherwise without authorization of the data's creator, the party receiving electronic files agrees that it will perform acceptance tests or procedures within 60 days, after which the receiving party shall be deemed to have accepted the data thus transferred. Any errors detected within the 60-day acceptance period will be corrected by the transferring party.

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

## ARTICLE 4 – AVAILABILITY OF LANDS; SUBSURFACE AND PHYSICAL CONDITIONS; HAZARDOUS ENVIRONMENTAL 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


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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 or a part thereof, 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 known to Owner of explorations and tests of subsurface conditions at or contiguous to the Site; and

2. those drawings known to Owner of physical conditions relating to existing surface or subsurface structures at the Site (except Underground Facilities).

B. *Limited Reliance by Contractor on Technical Data Authorized:* Contractor may rely upon the 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 or Engineer, or any of their officers, directors, members, partners, employees, agents, consultants, or subcontractors with respect to:

1. the completeness of such reports and drawings for Contractor's purposes, including, but not limited to, any aspects of the means, methods, techniques, sequences, and procedures of construction to be employed by Contractor, and safety precautions and programs incident thereto; or

2. other data, interpretations, opinions, and information contained in such reports or shown or indicated in such drawings; or

3. any Contractor interpretation of or conclusion drawn from any "technical data" or any such other data, interpretations, opinions, or information.

4.03 *Differing Subsurface or Physical Conditions*

A. *Notice:* If Contractor believes that any subsurface or physical condition 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.


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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 9.07 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 with respect to 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 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, neither Owner or Engineer, or any of their officers, directors, members, partners, employees, agents, consultants, or subcontractors shall 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 provided by others; and

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

      a. reviewing and checking all 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


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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 or 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:* The Supplementary Conditions identify those reports and drawings known to Owner relating to Hazardous Environmental Conditions that have been identified at the Site.

B. *Limited Reliance by Contractor on Technical Data Authorized:* Contractor may rely upon the 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 or Engineer, or any of their officers, directors, members, partners, employees, agents, consultants, or subcontractors with respect to:

1. the completeness of such reports and drawings for Contractor's purposes, including, but not limited to, any aspects of the means, methods, techniques, sequences and procedures of construction to be employed by Contractor and safety precautions and programs incident thereto; or

2. other data, interpretations, opinions and information contained in such reports or shown or indicated in such drawings; or

3. any Contractor interpretation of or conclusion drawn from any "technical data" or any such other data, interpretations, opinions or information.

C. Contractor shall not be responsible for 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.A); 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,


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if any. Promptly after consulting with Engineer, Owner shall take such actions as are necessary to permit Owner to timely obtain required permits and provide Contractor the written notice required by Paragraph 4.06.E.

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 written notice to Contractor: (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, and Engineer, and the officers, directors, members, partners, employees, agents, consultants, and subcontractors of each and any of them from and against all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to a Hazardous Environmental Condition, provided that such Hazardous Environmental Condition: (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.G 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 and Engineer, and the officers, directors, members, partners, employees, agents, consultants, and subcontractors of each and any of them from and against all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to a Hazardous Environmental Condition created by Contractor or by anyone for whom Contractor is responsible. Nothing in this Paragraph 4.06.H 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 do not 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 of Contractor's obligations under the Contract Documents. These bonds shall remain in effect until one year after the date when final payment becomes due or until completion of the correction period specified in Paragraph 13.07, whichever is later, 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 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


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an agent or attorney-in-fact must be accompanied by a certified copy of that individual's authority to bind the surety. The evidence of authority shall show that it is effective on the date the agent or attorney-in-fact signed each bond.

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 promptly notify Owner and Engineer and shall, within 20 days after the event giving rise to such notification, provide another bond and surety, both of which shall comply with the 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 and loss payee 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.

B. Owner shall deliver to Contractor, with copies to each additional insured and loss payee 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.

C. Failure of Owner to demand such certificates or other evidence of Contractor's full compliance with these insurance requirements or failure of Owner to identify a deficiency in compliance from the evidence provided shall not be construed as a waiver of Contractor's obligation to maintain such insurance.

D. Owner does not represent that insurance coverage and limits established in this Contract necessarily will be adequate to protect Contractor.

E. The insurance and insurance limits required herein shall not be deemed as a limitation on Contractor's liability under the indemnities granted to Owner in the Contract Documents.

5.04 *Contractor's Insurance*

A. Contractor shall purchase and maintain such 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:

   a. by any person as a result of an offense directly or indirectly related to the employment of such person by Contractor, or

   b. 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.


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B. The policies of insurance required by this Paragraph 5.04 shall:

1. with respect to insurance required by Paragraphs 5.04.A.3 through 5.04.A.6 inclusive, be written on an occurrence basis, include as additional insureds (subject to any customary exclusion regarding professional liability) Owner and Engineer, 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, members, partners, employees, agents, consultants, and subcontractors of each and any of all such additional insureds, and the insurance afforded to these additional insureds shall provide primary coverage for all claims covered thereby;

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 contractual liability insurance covering Contractor's indemnity obligations under Paragraphs 6.11 and 6.20;

4. contain a provision or endorsement that the coverage afforded will not be canceled, 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 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);

5. 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

6. include completed operations coverage:

   a. Such insurance shall remain in effect for two years after final payment.

   b. 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, and Engineer, and any other individuals or entities identified in the Supplementary Conditions, and the officers, directors, members, partners, employees, agents, consultants, and subcontractors of each and any of them, each of whom is deemed to have an insurable interest and shall be listed as a loss payee;

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

   3. include expenses incurred in the repair or replacement of any insured property


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(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 loss payee to whom a certificate of insurance has been issued.

B. Owner shall purchase and maintain such equipment breakdown 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, and Engineer, and any other individuals or entities identified in the Supplementary Conditions, and the officers, directors, members, partners, employees, agents, consultants and subcontractors of each and any of them, each of whom is deemed to have an insurable interest and shall be listed as a loss payee.

C. All the policies of insurance (and the certificates or other evidence thereof) required to be purchased and maintained in accordance with this 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 loss payee 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 this Paragraph 5.06, Owner shall, if possible, include such insurance, and the cost thereof will be charged to Contractor by appropriate Change Order. 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, and Engineer, and all other individuals or entities identified in the Supplementary Conditions as loss payees (and the officers, directors, members, partners, employees, agents, 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 loss payees thereunder. Owner and Contractor waive all rights against each other and their respective officers, directors, members, partners, employees, agents, consultants and subcontractors of each and any of them for all losses and damages caused by, arising out of or resulting from any of the perils or causes of loss covered by such policies and any other property insurance applicable to the Work; and, in addition, waive all such rights against Subcontractors and Engineer, and all other individuals or entities identified in the Supplementary Conditions as loss payees (and the officers, directors, members, partners, employees, agents, consultants, and subcontractors of each and any of them) under such policies for losses and damages so caused. None of the above waivers shall extend to the rights that any party making such waiver may have to the proceeds of insurance held by Owner as trustee or otherwise payable under any policy so issued.


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B. Owner waives all rights against Contractor, Subcontractors, and Engineer, and the officers, directors, members, partners, employees, agents, consultants and subcontractors of each and any of them for:

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

2. loss or damage to the completed Project or part thereof caused by, arising out of, or resulting from fire or other insured peril or cause of loss covered by any property insurance maintained on the completed Project or part thereof by Owner during partial 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, or Engineer, and the officers, directors, members, partners, employees, agents, 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 loss payees, 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.

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 non-conformance 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 2.01.B. 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.


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## 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. 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.

B. At all times during the progress of the Work, Contractor shall assign a competent resident superintendent who shall not be replaced without written notice to Owner and Engineer except under extraordinary circumstances.

6.02 *Labor; Working Hours*

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

B. Except as otherwise required for the safety or protection of persons or the Work or property at the Site or adjacent thereto, and except as otherwise stated in the Contract Documents, all Work at the Site shall be performed during regular working hours. Contractor will not permit the performance of Work on a 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 Contract Documents, Contractor shall provide and assume full responsibility for all services, materials, equipment, labor, transportation, construction equipment and machinery, tools, appliances, fuel, power, light, heat, telephone, water, sanitary facilities, temporary facilities, and all other facilities and incidentals necessary for the performance, testing, start-up, and completion of the Work.

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 special warranties and guarantees required by the Specifications shall expressly run to the benefit of Owner. If required by Engineer, Contractor shall furnish satisfactory evidence (including reports of required tests) as to the source, kind, and quality of materials and equipment.

C. All materials and equipment shall be stored, applied, installed, connected, erected, protected, used, cleaned, and conditioned in accordance with instructions of the applicable Supplier, except as otherwise may be provided in the Contract Documents.

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. Such adjustments will comply with any provisions of the General Requirements applicable thereto.

2. Proposed adjustments in the Progress Schedule that will change the Contract Times shall be submitted in accordance with the requirements of Article 12. Adjustments in Contract Times may only be made by a Change Order.

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


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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:

        1) it is at least equal in materials of construction, quality, durability, appearance, strength, and design characteristics;

        2) it will reliably perform at least equally well the function and achieve the results imposed by the design concept of the completed Project as a functioning whole; and

        3) it has a proven record of performance and availability of responsive service.

    b. Contractor certifies that, if approved and incorporated into the Work:

        1) there will be no increase in cost to the Owner or increase in Contract Times; and

        2) it will conform substantially to the detailed requirements of the item named in the Contract Documents.

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 if 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 requirements for review by Engineer will be as set forth in Paragraph 6.05.A.2.d, as supplemented by the General Requirements, and as Engineer may decide is appropriate under the circumstances.

    d. Contractor shall make written application to Engineer for review of a proposed substitute item of material or equipment that Contractor seeks to furnish or use. The application:

        1) shall certify that the proposed substitute item will:

            a) perform adequately the functions and achieve the results called for by the general design,

            b) be similar in substance to that specified, and

            c) be suited to the same use as that specified;

        2) will state:

            a) the extent, if any, to which the use of the proposed substitute item will prejudice Contractor's achievement of Substantial Completion on time,

            b) whether use of the proposed substitute item in the Work will require a change in any of the Contract Documents (or in the provisions of any other direct contract with Owner for other work on the Project) to adapt the design to the proposed substitute item, and


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c) whether incorporation or use of the proposed substitute item in connection with the Work is subject to payment of any license fee or royalty;

3) will identify:

a) all variations of the proposed substitute item from that specified, and

b) available engineering, sales, maintenance, repair, and replacement services; and

4) shall 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.

B. *Substitute Construction Methods or Procedures:* If a specific means, method, technique, sequence, or procedure of construction is 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 requirements for review by Engineer will be similar to those provided in Paragraph 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 may require Contractor to furnish additional data about the proposed substitute item. 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 a Change Order in the case of a substitute and 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 Engineer's costs in evaluating a substitute proposed or submitted by Contractor pursuant to Paragraphs 6.05.A.2 and 6.05.B. Whether or not Engineer approves a substitute so proposed or submitted by Contractor, Contractor shall reimburse Owner for the reasonable charges of Engineer for evaluating each such proposed substitute. Contractor shall also reimburse Owner for the reasonable charges of Engineer for making changes in the Contract Documents (or in the provisions of any other direct contract with Owner) resulting from the acceptance of each proposed substitute.

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. No acceptance by Owner of any such Subcontractor, Supplier, or other individual or entity, whether initially or as a replacement,


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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:

1. shall create for the benefit of any such Subcontractor, Supplier, or other individual or entity any contractual relationship between Owner or Engineer and any such Subcontractor, Supplier or other individual or entity; nor

2. shall create any obligation on the part of Owner or Engineer to pay or to see to the payment of any 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 a loss payee 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, and all other individuals or entities identified in the Supplementary Conditions to be listed as insureds or loss payees (and the officers, directors, members, partners, employees, agents, consultants, and subcontractors of each and any of them) for all losses and damages caused by, arising out of, relating to, or resulting from any of the perils or causes of loss covered by 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.

B. To the fullest extent permitted by Laws and Regulations, Owner shall indemnify and hold harmless Contractor, and its officers, directors, members, partners, employees, agents, consultants, and subcontractors from and against all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals, and all court or arbitration or other dispute resolution costs) arising out of or relating to any infringement of patent rights or copyrights incident to the use in the performance of the Work or resulting from the incorporation in the Work of any invention, design, process, product, or device specified in the Contract Documents, but not identified as being subject to payment of any license fee or royalty to others required by patent rights or copyrights.

C. To the fullest extent permitted by Laws and Regulations, Contractor shall indemnify and hold harmless Owner and Engineer, and the officers, directors, members, partners, employees, agents, consultants and subcontractors of each and any of them from and against all claims, costs, losses,


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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. Owner shall pay all charges of utility owners for connections for providing permanent service to the Work.

6.09 *Laws and Regulations*

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

B. If Contractor performs any Work 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 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 shall 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 and Engineer, and the officers, directors, members, partners, employees, agents, consultants and subcontractors of each and any of them from and against all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to any 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.


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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 the Work 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, 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. Such responsibility does not relieve Subcontractors of their responsibility for the safety of persons or property in the performance of their work, nor for compliance with applicable safety Laws and Regulations. Contractor shall take all necessary precautions for the safety of, and shall provide the necessary protection to prevent damage, injury or loss to:

1. all persons on the Site or who may be affected by the Work;

2. all the Work and materials and equipment to be incorporated therein, whether in storage on or off the Site; and

3. other property at the Site or adjacent thereto, including trees, shrubs, lawns, walks, pavements, roadways, structures, 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.

C. Contractor shall comply with the applicable requirements of Owner's safety programs, if any. The Supplementary Conditions identify any Owner's safety programs that are applicable to the Work.

D. Contractor shall inform Owner and Engineer of the specific requirements of Contractor's safety program with which Owner's and Engineer's employees and representatives must comply while at the Site.

E. All damage, injury, or loss to any property referred to in Paragraph 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 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


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entity directly or indirectly employed by any of them).

F. 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 and Samples to Engineer for review and approval in accordance with the accepted Schedule of Submittals (as required by Paragraph 2.07). Each submittal will be identified as Engineer may require.

1. *Shop Drawings:*

a. Submit number of copies specified in the General Requirements.

b. Data shown on the Shop Drawings will be complete with respect to quantities, dimensions, specified performance and design criteria, materials, and similar data to show Engineer the services, materials, and equipment Contractor proposes to provide and to enable Engineer to review the information for the limited purposes required by Paragraph 6.17.D.

2. *Samples:*

a. Submit number of Samples specified in the Specifications.

b. Clearly identify each Sample as to material, Supplier, pertinent data such as catalog numbers, the use for which intended and other data as Engineer may require to enable Engineer to review the submittal for the limited purposes required by Paragraph 6.17.D.

B. Where a Shop Drawing or Sample is required by the Contract Documents or the Schedule of Submittals, any related Work performed prior to Engineer's review and approval of the pertinent submittal will be at the sole expense and responsibility of Contractor.

C. *Submittal Procedures:*

1. Before submitting each Shop Drawing or Sample, Contractor shall have:

a. 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;

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

c. determined and verified the suitability of all materials offered with respect to the


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indicated application, fabrication, shipping, handling, storage, assembly, and installation pertaining to the performance of the Work; and

d. determined and verified all information relative to Contractor's responsibilities for means, methods, techniques, sequences, and procedures of construction, and safety precautions and programs incident thereto.

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

3. With each submittal, Contractor shall give Engineer specific written notice of any variations that the Shop Drawing or Sample may have from the requirements of the Contract Documents. This notice shall be both a written communication separate from the Shop Drawings or Sample submittal; and, in addition, by a specific notation made on each Shop Drawing or Sample submitted to Engineer for review and approval of each such variation.

D. *Engineer's Review:*

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

2. Engineer's review and approval will not extend to means, methods, techniques, sequences, or procedures of construction (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 shall not relieve Contractor from responsibility for any variation from the requirements of the Contract Documents unless Contractor has complied with the requirements of Paragraph 6.17.C.3 and Engineer has given written approval of each such variation by specific written notation thereof incorporated in or accompanying the Shop Drawing or Sample. Engineer's review and approval shall not relieve Contractor from responsibility for complying with the requirements of Paragraph 6.17.C.1.

E. *Resubmittal Procedures:*

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

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 that all Work will be in accordance with the Contract Documents and will not be defective. Engineer and its officers, directors, members, partners, employees, agents, consultants, and subcontractors shall be entitled to rely on representation of Contractor's warranty and guarantee.

B. Contractor's warranty and guarantee hereunder excludes defects or damage caused by:

1. abuse, modification, or improper maintenance or operation by persons other than Contractor, Subcontractors, Suppliers, or any other


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individual or entity for whom Contractor is responsible; or

2. normal wear and tear under normal usage.

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

1. observations by Engineer;

2. recommendation by Engineer or payment by Owner of any progress or final payment;

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

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

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

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

7. 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 and Engineer, and the officers, directors, members, partners, employees, agents, consultants and subcontractors of each and any of them from and against all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to the performance of the Work, provided that any such claim, cost, loss, or damage is attributable to bodily injury, sickness, disease, or death, or to injury to or destruction of tangible property (other than the Work itself), including the loss of use resulting therefrom but only to the extent caused by any negligent act or omission of Contractor, any Subcontractor, any Supplier, or any individual or entity directly or indirectly employed by any of them to perform any of the Work or anyone for whose acts any of them may be liable .

B. In any and all claims against Owner or Engineer or any of their officers, directors, members, partners, employees, agents, consultants, or subcontractors by any employee (or the survivor or personal representative of such employee) of Contractor, any Subcontractor, any Supplier, or any individual or entity directly or indirectly employed by any of them to perform any of the Work, or anyone for whose acts any of them may be liable, the indemnification obligation under Paragraph 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 officers, directors, members, partners, employees, agents, consultants and subcontractors arising out of:

1. the preparation or approval of, or the failure to prepare or approve maps, Drawings, opinions, reports, surveys, Change Orders, designs, or Specifications; or

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

6.21 *Delegation of Professional Design Services*

A. Contractor will not be required to provide professional design services unless such services are specifically required by the Contract Documents for a portion of the Work or unless such services are required to carry out Contractor's responsibilities for construction means, methods, techniques, sequences and procedures. Contractor shall not be required to provide professional services in violation of applicable law.

B. If professional design services or certifications by a design professional related to systems, materials or equipment are specifically required of Contractor by the Contract Documents, Owner and Engineer will specify all performance and design criteria that such services must satisfy. Contractor shall cause such services or


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certifications to be provided by a properly licensed professional, whose signature and seal shall appear on all drawings, calculations, specifications, certifications, Shop Drawings and other submittals prepared by such professional. Shop Drawings and other submittals related to the Work designed or certified by such professional, if prepared by others, shall bear such professional's written approval when submitted to Engineer.

C. Owner and Engineer shall be entitled to rely upon the adequacy, accuracy and completeness of the services, certifications or approvals performed by such design professionals, provided Owner and Engineer have specified to Contractor all performance and design criteria that such services must satisfy.

D. Pursuant to this Paragraph 6.21, Engineer's review and approval of design calculations and design drawings will be only for the limited purpose of checking for conformance with performance and design criteria given and the design concept expressed in the Contract Documents. Engineer's review and approval of Shop Drawings and other submittals (except design calculations and design drawings) will be only for the purpose stated in Paragraph 6.17.D.1.

E. Contractor shall not be responsible for the adequacy of the performance or design criteria required by the Contract Documents.

## ARTICLE 7 – OTHER WORK AT THE SITE

7.01 *Related Work at Site*

A. Owner may perform other work related to the Project at the Site with Owner's employees, or through 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, each utility owner, and Owner, if Owner is performing other work with Owner's employees, proper and safe access to the Site, provide a reasonable opportunity for the introduction and storage of materials and equipment and the execution of such other work, and properly coordinate the Work with theirs. Contractor shall do all cutting, fitting, and patching of the Work that may be required to properly connect or otherwise make its several parts come together and properly integrate with such other work. Contractor shall not endanger any work of others by cutting, excavating, or otherwise altering such work; provided, however, that Contractor may cut or alter others' work with the written consent of Engineer and the others whose work will be affected. 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.


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

7.03 *Legal Relationships*

A. Paragraphs 7.01.A and 7.02 are not applicable for utilities not under the control of Owner.

B. Each other direct contract of Owner under Paragraph 7.01.A shall provide that the other contractor is liable to Owner and Contractor for the reasonable direct delay and disruption costs incurred by Contractor as a result of the other contractor's wrongful actions or inactions.

C. Contractor shall be liable to Owner and any other contractor under direct contract to Owner for the reasonable direct delay and disruption costs incurred by such other contractor as a result of Contractor's wrongful action or inactions.

## 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 When Due*

A. Owner shall make payments to Contractor 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 with respect to providing lands and easements and providing engineering surveys to establish reference points are set forth in Paragraphs 4.01 and 4.05. Paragraph 4.02 refers to Owner's identifying and making available to Contractor copies of reports of explorations and tests of subsurface conditions and drawings of physical conditions relating to existing surface or subsurface structures at the Site.

8.06 *Insurance*

A. Owner's responsibilities, if any, with respect to 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 with 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. Upon request of Contractor, Owner shall furnish Contractor reasonable evidence that financial arrangements have been made to satisfy Owner's obligations under the Contract Documents.

8.12 *Compliance with Safety Program*

A. While at the Site, Owner's employees and representatives shall comply with the specific applicable requirements of Contractor's safety programs of which Owner has been informed pursuant to Paragraph 6.13.D.


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## 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.

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 9.09. 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 authority and responsibilities of any such Resident Project Representative and assistants will be as provided in the Supplementary Conditions, and limitations on the responsibilities thereof will be as provided in Paragraph 9.09. 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 *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 or Contractor believes that a Field Order justifies an adjustment in the Contract Price or Contract Times, or both, and the parties are unable to agree on entitlement to or on the amount or extent, if any, of any such adjustment, a Claim may be made therefor as provided in Paragraph 10.05.

9.05 *Rejecting Defective Work*

A. Engineer will have authority to 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.

9.06 *Shop Drawings, Change Orders and Payments*

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

B. In connection with Engineer's authority, and limitations thereof, as to design calculations and design drawings submitted in response to a


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delegation of professional design services, if any, see Paragraph 6.21.

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

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

9.07 *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.

9.08 *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. All matters in question and other matters between Owner and Contractor arising prior to the date final payment is due relating to the acceptability of the Work, and the interpretation of the requirements of the Contract Documents pertaining to the performance of the Work, will be referred initially to Engineer in writing within 30 days of the event giving rise to the question.

B. Engineer will, with reasonable promptness, render a written decision on the issue referred. If Owner or Contractor believes that any such decision entitles them to an adjustment in the Contract Price or Contract Times or both, a Claim may be made under Paragraph 10.05. The date of Engineer's decision shall be the date of the event giving rise to the issues referenced for the purposes of Paragraph 10.05.B.

C. Engineer's written decision on the issue referred will be final and binding on Owner and Contractor, subject to the provisions of Paragraph 10.05.

D. When functioning as interpreter and judge under this Paragraph 9.08, Engineer will not show partiality to Owner or Contractor and will not be liable in connection with any interpretation or decision rendered in good faith in such capacity.

9.09 *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 9.09 shall also apply to the Resident Project Representative, if any, and assistants, if any.


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9.10 *Compliance with Safety Program*

A. While at the Site, Engineer's employees and representatives shall comply with the specific applicable requirements of Contractor's safety programs of which Engineer has been informed pursuant to Paragraph 6.13.D.

## ARTICLE 10 – CHANGES IN THE WORK; CLAIMS

10.01 *Authorized Changes in the Work*

A. Without invalidating the Contract and without notice to any surety, Owner may, at any time or from time to time, order additions, deletions, or revisions in the Work by 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.D.

10.03 *Execution of Change Orders*

A. Owner and Contractor shall execute appropriate Change Orders recommended by Engineer 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 the provisions of any bond require notice to be given to a surety of any change affecting the general scope of the Work or the provisions of the Contract Documents (including, but not limited to, Contract Price or Contract Times), the giving of any such notice will be Contractor's responsibility. The amount of each applicable bond will be adjusted to reflect the effect of any such change.

10.05 *Claims*

A. *Engineer's Decision Required*: All Claims, except those waived pursuant to Paragraph 14.09, shall be referred to the Engineer for decision. A decision by Engineer shall be required as a condition precedent to any exercise by Owner or Contractor of any rights or remedies either may otherwise have under the Contract Documents or by Laws and Regulations in respect of such Claims.

B. *Notice:* Written notice stating the general nature of each Claim 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. The responsibility to substantiate a Claim shall rest with the party making the Claim. Notice of the amount or extent of the Claim, 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


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or more accurate data in support of such Claim). 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 Times 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).

C. *Engineer's Action*: Engineer will review each Claim and, within 30 days after receipt of the last submittal of the claimant or the last submittal of the opposing party, if any, take one of the following actions in writing:

1. deny the Claim in whole or in part;

2. approve the Claim; or

3. notify the parties that the Engineer is unable to resolve the Claim if, in the Engineer's sole discretion, it would be inappropriate for the Engineer to do so. For purposes of further resolution of the Claim, such notice shall be deemed a denial.

D. In the event that Engineer does not take action on a Claim within said 30 days, the Claim shall be deemed denied.

E. Engineer's written action under Paragraph 10.05.C or denial pursuant to Paragraphs 10.05.C.3 or 10.05.D will be final and binding upon Owner and Contractor, unless Owner or Contractor invoke the dispute resolution procedure set forth in Article 16 within 30 days of such action or denial.

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

## ARTICLE 11 – COST OF THE WORK; 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, except those excluded in Paragraph 11.01.B, 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 not include any of the costs itemized in Paragraph 11.01.B, and shall include only the following items:

1. Payroll costs for employees in the direct employ of Contractor in the performance of the Work under schedules of job classifications agreed upon by Owner and Contractor. Such employees shall include, without limitation, superintendents, foremen, and other personnel employed full time on the Work. Payroll costs for employees not employed full time on the Work shall be apportioned on the basis of their time spent on the Work. Payroll costs shall include, but not be limited to, salaries and wages plus the cost of fringe benefits, which shall include social security contributions, unemployment, excise, and payroll taxes, workers' compensation, health and retirement benefits, bonuses, sick leave, 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


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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, as imposed by Laws and Regulations.

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

   f. Losses and damages (and related expenses) caused by damage to the Work, not compensated by insurance or otherwise, sustained by Contractor in connection with the performance of the Work (except losses and damages within the deductible amounts of property insurance established in accordance with Paragraph 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, express and courier services, and similar petty cash items in connection with the Work.

   i. 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, safety managers, engineers, architects, estimators, attorneys, auditors, accountants, purchasing and contracting agents, expediters, timekeepers, clerks, and other personnel employed by Contractor, whether at the Site or in Contractor's principal or branch office for


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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.

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 *Allowances*

A. It is understood that Contractor has included in the Contract Price all allowances so named in the Contract Documents and shall cause the Work so covered to be performed for such sums and by such persons or entities as may be acceptable to Owner and Engineer.

B. *Cash Allowances:*

1. Contractor agrees that:

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

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

C. *Contingency Allowance:*

1. Contractor agrees that a contingency allowance, if any, is for the sole use of Owner to cover unanticipated costs.

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

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.

B. The estimated quantities of items of Unit Price Work are not guaranteed and are solely for the purpose of comparison of Bids and determining an initial Contract Price. 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 9.07.


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C. Each unit price will be deemed to include an amount considered by Contractor to be adequate to cover Contractor's overhead and profit for each separately identified item.

D. 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 to any other item of Work; and

3. 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. 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 Paragraphs 12.01.C.2.a and 12.01.C.2.b 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


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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 may only be changed by a Change Order. Any Claim for an adjustment in the Contract Times 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 covered by a Change Order or any Claim for an adjustment in the Contract Times will be determined in accordance with the provisions of this Article 12.

12.03 *Delays*

A. Where Contractor is prevented from completing any part of the Work within the Contract Times due to delay beyond the control of Contractor, the Contract Times 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.

B. If Owner, Engineer, or other contractors or utility owners performing other work for Owner as contemplated by Article 7, or anyone for whom Owner is responsible, delays, disrupts, or interferes with the performance or progress of the Work, then Contractor shall be entitled to an equitable adjustment in the Contract Price or the Contract Times, or both. Contractor's entitlement to an adjustment of the Contract Times is conditioned on such adjustment being essential to Contractor's ability to complete the Work within the Contract Times.

C. If Contractor is delayed in the performance or progress of the Work by fire, flood, epidemic, abnormal weather conditions, acts of God, acts or failures to act of utility owners not under the control of Owner, or other causes not the fault of and beyond control of Owner and Contractor, then Contractor shall be entitled to an equitable adjustment in Contract Times, if such adjustment is essential to Contractor's ability to complete the Work within the Contract Times. Such an adjustment shall be Contractor's sole and exclusive remedy for the delays described in this Paragraph 12.03.C.

D. Owner, Engineer, and their officers, directors, members, partners, employees, agents, consultants, or subcontractors 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.

E. Contractor shall not be entitled to an adjustment in Contract Price or Contract Times for 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.

## 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. Defective Work may be rejected, corrected, or accepted as provided in this Article 13.

13.02 *Access to Work*

A. Owner, Engineer, their consultants and 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, inspection, and testing. Contractor shall provide them proper and safe conditions for such access and advise them of Contractor's safety procedures and programs so that they may comply therewith as applicable.


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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 Paragraph 13.04.C; 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, Contractor shall, if requested by Engineer, uncover such Work 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.

C. If it is found that the uncovered 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.

D. If the uncovered Work is not found to be defective, Contractor shall be allowed an increase in the Contract Price or an extension of the Contract Times, or both, directly attributable to such uncovering, exposure, observation, inspection, testing, replacement, and reconstruction. If the parties are unable to agree as to the amount or extent thereof, 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


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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. Promptly after receipt of written notice, 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).

B. When correcting defective Work under the terms of this Paragraph 13.06 or Paragraph 13.07, Contractor shall take no action that would void or otherwise impair Owner's special warranty and guarantee, if any, on said Work.

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 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:

1. repair such defective land or areas; or

2. correct such defective Work; or

3. if the defective Work has been rejected by Owner, remove it from the Project and replace it with Work that is not defective, and

4. satisfactorily correct or repair or remove and replace any damage to other Work, to the work of others or other land or areas resulting therefrom.

B. If Contractor does not promptly comply with the terms of Owner's written instructions, or in an emergency where delay would cause serious risk of loss or damage, Owner may have the defective Work corrected or repaired or may have the rejected Work removed and replaced. 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.

C. In special circumstances where a particular item of equipment is placed in continuous service before Substantial Completion of all the Work, the correction period for that item may start to run from an earlier date if so provided in the Specifications.

D. Where defective Work (and damage to other Work resulting therefrom) has been corrected or removed and replaced under this Paragraph 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.

E. 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 for 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


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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, or remedy any such deficiency.

B. In exercising the rights and remedies under this Paragraph 13.09, Owner shall proceed expeditiously. In connection with such corrective or remedial action, Owner may exclude Contractor from all or part of the Site, take possession of all or part of the Work and suspend Contractor's services related thereto, 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 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 in the Agreement for each progress payment (but not more often than once a month), Contractor shall submit to Engineer for review an Application for Payment filled out and signed by Contractor covering the Work completed as of the date of the Application and accompanied by such supporting documentation as is required by the Contract Documents. If payment is requested on the basis of materials and equipment not incorporated in the Work but delivered and suitably stored at the Site or at another location agreed to in writing, the Application for Payment shall also be accompanied by a bill of sale, invoice, or other documentation warranting that Owner has received the materials and equipment free and clear of all Liens and evidence that the materials and equipment are covered by appropriate property insurance or other arrangements to


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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 of the executed Work as an experienced and qualified design professional, and on Engineer's review of the Application for Payment and the accompanying data and schedules, that to the best of Engineer's knowledge, information and belief:

   a. the Work has progressed to the point indicated;

   b. the quality of the Work is generally in accordance with the Contract Documents (subject to an evaluation of the Work as a functioning whole prior to or upon Substantial Completion, the results of any subsequent tests called for in the Contract Documents, a final determination of quantities and classifications for Unit Price Work under Paragraph 9.07, and any other qualifications stated in the recommendation); and

   c. the conditions precedent to Contractor's being entitled to such payment appear to have been fulfilled in so far as it is Engineer's responsibility to observe the Work.

3. By recommending any such payment Engineer will not thereby be deemed to have represented that:

   a. inspections made to check the quality or the quantity of the Work as it has been performed have been exhaustive, extended to every aspect of the Work in progress, or involved detailed inspections of the Work beyond the responsibilities specifically assigned to Engineer in the Contract Documents; or

   b. there may not be other matters or issues between the parties that might entitle Contractor to be paid additionally by Owner or entitle Owner to withhold payment to Contractor.

4. Neither Engineer's review of Contractor's Work for the purposes of recommending payments nor Engineer's recommendation of any payment, including final payment, will impose responsibility on Engineer:

   a. to supervise, direct, or control the Work, or

   b. for the means, methods, techniques, sequences, or procedures of construction, or the safety precautions and programs incident thereto, or

   c. for Contractor's failure to comply with Laws and Regulations applicable to Contractor's performance of the Work, or

   d. to make any examination to ascertain how or for what purposes Contractor has used the moneys paid on account of the Contract Price, or

   e. to determine that title to any of the Work, materials, or equipment has passed to Owner free and clear of any Liens.

5. Engineer may refuse to recommend the whole or any part of any payment if, in Engineer's opinion, it would be incorrect to make the


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representations to Owner stated 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 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 will give Contractor immediate written notice (with a copy to Engineer) stating the reasons for such action and promptly pay Contractor any amount remaining after deduction of the amount so withheld. Owner shall promptly pay Contractor the amount so withheld, or any adjustment thereto agreed to by Owner and Contractor, when Contractor remedies the reasons for such action.

3. Upon a subsequent determination that Owner's refusal of payment was not justified, the amount wrongfully withheld shall be treated as an amount due as determined by Paragraph 14.02.C.1 and subject to interest as provided in the Agreement.

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.

B. Promptly after Contractor's notification, Owner, Contractor, and Engineer shall make an inspection of the Work to determine the status of completion. If Engineer does not consider the Work substantially complete, Engineer will notify Contractor in writing giving the reasons therefor.

C. If Engineer considers the Work substantially complete, Engineer will deliver to Owner a 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


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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.

D. 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.

E. Owner shall have the right to exclude Contractor from the Site after the date of Substantial Completion subject to allowing Contractor reasonable access to remove its property and complete or correct items on the tentative list.

14.05 *Partial Utilization*

A. Prior to Substantial Completion of all the Work, Owner may use or occupy any substantially completed part of the Work which has specifically been identified in the Contract Documents, or which Owner, Engineer, and Contractor agree constitutes a separately functioning and usable part of the Work that can be used by Owner for its intended purpose without significant interference with Contractor's performance of the remainder of the Work, subject to the following conditions:

1. Owner at any time may request Contractor in writing to permit Owner to use or occupy any such part of the Work which Owner believes to be ready for its intended use and substantially complete. If and when Contractor agrees that such part of the Work is substantially complete, Contractor, Owner, and Engineer will follow the procedures of Paragraph 14.04.A through D for that part of the Work.

2. 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.

3. Within a reasonable time after either such request, Owner, Contractor, and Engineer shall make an inspection of that part of the Work to determine its status of completion. If Engineer does not consider that part of the Work to be substantially complete, Engineer will notify Owner and Contractor in writing giving the reasons therefor. If Engineer considers that part of the Work to be substantially complete, the provisions of Paragraph 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.

4. No use or 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.


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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:

   a. all documentation called for in the Contract Documents, including but not limited to the evidence of insurance required by Paragraph 5.04.B.6;

   b. consent of the surety, if any, to final payment;

   c. a list of all Claims against Owner that Contractor believes are unsettled; and

   d. 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 might in any way be responsible, or which might in any way result in liens or other burdens on Owner's property, have been paid or otherwise satisfied. If any Subcontractor or Supplier fails to furnish such a release or receipt in full, Contractor may furnish a bond or other collateral satisfactory to Owner to indemnify Owner against any Lien.

B. *Engineer's Review of Application and Acceptance:*

1. If, on the basis of Engineer's observation of the Work during construction and final inspection, and Engineer's review of the final Application for Payment and accompanying documentation as required by the Contract Documents, Engineer is satisfied that the Work has been completed and Contractor's other obligations under the Contract 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, less any sum Owner is entitled to set off against Engineer's recommendation, including but not limited to liquidated damages, will become due and 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 (for Work fully completed and accepted) and recommendation of Engineer, and without terminating the Contract, 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


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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 accordance with the requirements herein and expressly acknowledged by Owner in writing as 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 granted 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 repeated 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 surety) seven days written notice of its intent to terminate the services of Contractor:

1. 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);

2. 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

3. complete the Work as Owner may deem expedient.

C. If Owner proceeds as provided in Paragraph 15.02.B, Contractor shall not be entitled to receive any further payment until the Work is completed. If the unpaid balance of the Contract Price exceeds 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.


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D. Notwithstanding Paragraphs 15.02.B and 15.02.C, Contractor's services will not be terminated if Contractor begins within seven days of receipt of notice of intent to terminate to correct its failure to perform and proceeds diligently to cure such failure within no more than 30 days of receipt of said notice.

E. 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.

F. If and to the extent that Contractor has provided a performance bond under the provisions of Paragraph 5.01.A, the termination procedures of that bond shall supersede the provisions of Paragraphs 15.02.B and 15.02.C.

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, terminate the Contract. In such case, Contractor shall be paid for (without duplication of any items):

1. completed and acceptable Work executed in accordance with the Contract Documents prior to the effective date of termination, including fair and reasonable sums for overhead and profit on such Work;

2. expenses sustained prior to the effective date of termination in performing services and furnishing labor, materials, or equipment as required by the Contract Documents in connection with uncompleted Work, plus fair and reasonable sums for overhead and profit on such expenses;

3. 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. 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, (i) the Work is suspended for more than 90 consecutive days by Owner or under an order of court or other public authority, or (ii) Engineer fails to act on any Application for Payment within 30 days after it is submitted, or (iii) 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.

B. In lieu of terminating the Contract and without prejudice to any other right or remedy, if Engineer has failed to act on an Application for Payment within 30 days after it is submitted, or Owner has failed for 30 days to pay Contractor any sum finally determined to be due, Contractor may, seven days after written notice to Owner and Engineer, stop the Work until payment is made of all such amounts due Contractor, including interest thereon. The provisions of this Paragraph 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. Either Owner or Contractor may request mediation of any Claim submitted to Engineer for a decision under Paragraph 10.05 before such decision becomes final and binding. The mediation will be governed by the Construction Industry Mediation Rules of the American Arbitration Association in effect as of the Effective Date of the Agreement. The request for mediation shall be submitted in writing to the American Arbitration Association and the other party to the Contract. Timely submission of the request shall stay the effect of Paragraph 10.05.E.


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B. Owner and Contractor shall participate in the mediation process in good faith. The process shall be concluded within 60 days of filing of the request. The date of termination of the mediation shall be determined by application of the mediation rules referenced above.

C. If the Claim is not resolved by mediation, Engineer's action under Paragraph 10.05.C or a denial pursuant to Paragraphs 10.05.C.3 or 10.05.D shall become final and binding 30 days after termination of the mediation unless, within that time period, Owner or Contractor:

1. elects in writing to invoke any dispute resolution process provided for in the Supplementary Conditions; or

2. agrees with the other party to submit the Claim to another dispute resolution process; or

3. gives written notice to the other party of the intent to submit the Claim to a court of competent jurisdiction.

## ARTICLE 17 – MISCELLANEOUS

17.01 *Giving Notice*

A. Whenever any provision of the Contract Documents requires the giving of written notice, it will be deemed to have been validly given if:

1. 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

2. 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. 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 Contract or termination of the services of Contractor.

17.05 *Controlling Law*

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

17.06 *Headings*

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


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SECTION 00800

SUPPLEMENTARY CONDITIONS

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PART II - STATE GOVERNMENT PROVISIONS

1.0. STATE OF ARKANSAS PROVISIONS

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# SUPPLEMENTARY CONDITIONS

## PART I - AMENDMENTS TO GENERAL CONDITIONS

These Supplementary Conditions amend or supplement the Standard General Conditions of the Construction Contract (EJCDC Document No. C-700, 2007 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.

### ARTICLE 1 - DEFINITIONS AND TERMINOLOGY

SC-1.01A.12.

In the third line after the of the word "Agreement," insert "the Invitation To Bid, Instructions to Bidders."

SC-1.01A.19.

Delete Paragraph 1.01A.19. in its entirety and replace with the following:

19. Engineer shall mean CDM SMITH, Inc, 8140 Walnut Hill LN, Suite 1000, Dallas, TX, 75231 or its designated representative.

SC-1.01A.44.

Insert the following at the beginning of the definition.

"The Work required by the Contract has been completed except for work having a Contract Price of less than one per cent of the then adjusted total contract price, or...."

SC-1.01A.42.

Delete paragraph 1.01A.42. in its entirety and replace with the following:

42. Specifications - Sections included under Division 1 through Division 16 of the Project Manual.

SC-1.01A.52.

Add the following new definitions after paragraph 1.01A.51, of the General Conditions:

53. Conditions of the Contract - The combined General Conditions and Supplementary Conditions.

54. Design Engineer – Same as Item 19, Engineer.

55. General Contractor – Same as Item 15, Contractor.

56. Modification – (a) Written Amendment; (b) Change Order; (c) Field Order; (d) Work Change Directive.
57. Registered Bid Documents – Numbered bidding documents as issued by the Engineer.

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SC-1.02B.

Delete Paragraph 1.02C. of the General Conditions and replace with the following:

C. *Day*

1. A "calendar day" shall be a day of twenty-four hours measured from midnight to the next midnight, and is any day of the year, no days being exempted.

2. A "working day" shall be a day, not including Saturdays, Sundays or any of the following holidays: New Year's Day, President's Day, Memorial Day, Independence Day, Labor Day, Thanksgiving Day, and Christmas Day, in which weather or other conditions not under the control of the Contractor will permit construction of the principal units of the work for a period of not less than seven hours between 7:00 a.m. and 6:00 p.m.

ARTICLE 2 - PRELIMINARY MATTERS

SC-2.01B.

Delete paragraph 2.01B. of the General Conditions in its entirety and replace with the following:

B. Before any Work at the site is started, Contractor shall deliver to Owner, with copies to Engineer and each additional insured identified in Article 5 of the Supplementary Conditions, certificates of insurance (and other evidence of insurance which Owner or any additional insured may reasonably request) which Contractor is required to purchase and maintain in accordance with the requirements of Article 5.

SC-2.02A.

Delete Paragraph 2.02A of the General Conditions in its entirely and replace with the following:

A. Owner shall furnish Contractor three (3) sets of Contract Documents, which shall include Drawings and Specifications. Additional copies will be provided upon Contractor's request at the cost of reproduction plus any shipping charges.

SC-2.05.

Add the following as Paragraph 2.05B.

B. *Contractor's Review of Construction 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. In the event of a conflict in the Drawings, Specifications, or other portions of the Contract Documents which were not reported prior to the Bidding of the Contract, the Contractor shall be deemed to have included the most expensive in his Bid.
SC-2.07A.

Amend Paragraph 2.07A. by adding the following:

Such acceptance of the contract completion schedule in no way affects the Contract Times.

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ARTICLE 3 - CONTRACT DOCUMENTS: INTENT, AMENDING, REUSE

SC-3.01A.

Amend Paragraph 3.01A. by adding the following:

The titles and headings contained in the contract documents and the subject organization are used only to facilitate reference, and in no way define or limit the scope of intent of any of the provisions of this contract.

SC-3.01C.

Add a new paragraph immediately after Paragraph 3.01C. of the General Conditions which is to read as follows:

D. Each and every provision of law and clause required by law to be inserted in these Contract Documents shall be deemed to be inserted herein, and they shall be read and enforced as though it were included herein, and if through mistake or otherwise, any such provision is not inserted, or if not correctly inserted, then upon the application of either party, the Contract Documents shall forthwith be physically amended to make such insertion.

E. The Contract Documents comprise the entire Agreement between Owner and Contractor. The Contract Documents may be altered only by a Modification.

Delete 3.03A.3 in its entirety and replace with the following:

In the event of a conflict in the Drawings, Specifications, or other portions of the Contract Documents which were not reported prior to the Bidding of the Contract, the Contractor shall be deemed to have included the most expensive in his Bid.

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

SC-4.01A.

Add the following new paragraph immediately after paragraph 4.01A. of the General Conditions which is to read as follows:

1. If all lands and rights-of-way are not obtained as herein contemplated before construction begins, Contractor shall begin the Work upon such land and rights-of-way as Owner has previously acquired.

SC-4.02.

Delete Paragraph 4.02 of the General Conditions in its entirety and replace with the following:

4.02 *Examination of Plans, Specifications and Site of the Work*

A. Bidders are advised that the plans, specifications and other documents listed in Paragraph 3.01C. shall constitute all the information which the Owner shall furnish. Bidders are required, prior to submitting any proposal, to review the plans and read the specifications, proposal, contract and bond forms carefully; to visit

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the site of the work; to examine carefully local conditions; to inform themselves by their independent research, tests and investigations of the difficulties to be encountered and judge for themselves the accessibility of the work and all attending circumstances affecting the cost of doing the work or time required for its completions; and to obtain all information required to make an intelligent proposal.

B. No information given by the Owner or any official thereof, other than that shown on the plans and contained in the specifications, proposals and other contact documents, shall be binding upon the Owner. Bidders shall rely exclusively upon their own estimates, investigations, tests and other data which are necessary for full and complete information upon which the proposal may be based. Any bidder, by submitting his bid, represents and warrants: that he has prepared his bid in accordance with the specifications, with full knowledge and understanding of the terms and provisions thereof, that he has reviewed, studied and examined the bid prior to the signing and submission of same; and that he was cognizant of the terms of his proposal, verified his calculations and found them to be correct and agrees to be bound thereby.

SC-4.05A.

Add the following new paragraph immediately after paragraph 4.05A. of the General Conditions which is to read as follows:

B. Engineer may check the lines, elevations, reference marks, batter boards, etc., set by Contractor, and Contractor shall correct any errors disclosed by such check. Such a check shall not be considered as approval of Contractor's work and shall not relieve Contractor of the responsibility for accurate construction of the entire Work. Contractor shall furnish personnel to assist Engineer in checking lines and grades.

ARTICLE 5 - BONDS AND INSURANCE

SC-5.02A.

Delete Paragraph 5.02A. of the General Conditions in its entirety and replace with the following:

A. All Bonds and insurance required by the Contract Documents to be purchased and maintained by Contractor shall be obtained from surety or insurance companies that are duly licensed or authorized in the jurisdiction in which the Projects 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. Any insurance or bond required by this Contract shall be secured from an insurance or indemnity carrier licensed to do business in the State of Arkansas.

SC-5.03B.

Delete the following from Paragraph 5.03B.:

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.

Add 3 new paragraphs immediately after paragraph 5.03B of the General Conditions which are to read as follows:

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C. Contractor shall provide evidence of its insurance coverage on the ACORD certificate of insurance form and shall include the following statement in its entirety in the section of the form entitled "Description of Operations/Locations/Vehicles/Special Items".

City Corp and CDM Smith [Inc.], and their officers, directors, partners, employees and other consultants and subcontractors are named as additional insureds with respect to the insured's Commercial General Liability and Automobile Liability Insurance Policies. All insurers waive all rights of subrogation against City Corp and CDM Smith [Inc.], their officers, directors, partners, employees and other consultants and subcontractors. All insurance is primary for all claims covered thereby. Commercial General Liability Insurance includes contractual liability coverage.

All policies shall be endorsed to read: "Said Policy shall not be cancelled, nonrenewed or materially changed without thirty (30) days advanced written notice being given to the Owner (City) except when the policy is being cancelled for nonpayment of premium in which case ten (10) days advanced written notice is required."

SC-5.04A.

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 law:

5.04A.1. and 5.04A.2. Workers' Compensation

| | | |
|---|---|---|
| (1) Worker's Compensation | Statutory | |
| (2) Employer's Liability | $1,000,000 | |

5.04A.3., 5.04A.4., and 5.04A.5. Commercial General Liability including Premise/Operations; Explosion, Collapse and Underground Property Damage; Products/Completed Operations, Broad Form Contractual, Independent Contractors; Broad Form Property Damage; and Personal Injury liabilities:

| | | |
|---|---|---|
| (1) Bodily Injury: | $1,000,000 | Each Occurrence |
| | $1,000,000 | Annual Aggregate |
| (2) Property Damage: | $1,000,000 | Each Occurrence |
| | $1,000,000 | Annual Aggregate |
| (3) Personal Injury: | $1,000,000 | Annual Aggregate |

5.04A.6. Comprehensive Automobile Liability including all owned (private and others), hired and non-owned vehicles:

| | | |
|---|---|---|
| (1) Bodily Injury | $1,000,000 | Each Person |
| | $1,000,000 | Each Accident |
| (2) Property Damage | $1,000,000 | Each Occurrence |

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SC 5.04B.1.

Delete paragraph 5.04B.1. of the General Conditions in its entirety and replace with the following:

The insurance required by paragraph 5.04A.3 through 5.04A.6 inclusive will provide primary coverage for all claims covered thereby. With respect to insurance required by Paragraph 5.04.A.6 include as additional insured Owner and Engineer, 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, members, employees, agents, consultants and subcontractors of each and any of all such additional insureds

5.04B.1a Include City Corp, Brown Engineers, Inc., and CDM Smith, Inc. as an additional insured on the insurance required by paragraph 5.04A.6.

SC-5.04B.6.

Add two following new paragraphs immediately after paragraph 5.04B.6. of the General Conditions which is to read as follows:

7. Contractor may purchase and maintain excess liability insurance in the umbrella form in order to satisfy the minimum amounts required for the insurance to be purchased and maintained in accordance with paragraph 5.04. Evidence of such excess liability insurance shall be delivered to Owner in accordance with paragraph 2.01 in the form of a certificate indicating the policy numbers and minimum coverage amounts of all underlying insurance. The umbrella liability insurance shall have a combined single limit of not less than $5,000,000.

8. All polices required by this paragraph 5.04 shall contain provisions to the effect that the insurer(s) waive all right of subrogation against the Owner, Engineer and their officers, directors, partners, employees and other consultants and subcontractors of each and any of them.

SC-5.05A.

Delete paragraph 5.05A. of the General Conditions in its entirety and replace with the following:

A. Contractor shall purchase and maintain a separate Owner's Protective Liability policy, issued to Owner at the expense of Contractor, including Owner and Engineer as named insured. This insurance shall provide coverage for not less than the following amounts:

| | | | |
|---|---|---|---|
| 5.05A.1. | Bodily Injury | $1,000,000 | Each Occurrence |
| 5.05A.2. | Property Damage | $1,000,000 | Each Occurrence |
| | | $1,000,000 | Annual Aggregate |

SC-5.05A

Add the following new paragraph immediately after paragraph 5.05.A.2 of the General Conditions which is to read as follows:

B. All polices required by this paragraph 5.05 shall contain provisions to the effect that the insurer(s) waive all rights of subrogation against the Owner, Engineer and their officers, directors, partners, employees and other consultants and subcontractors of each and any of them.

Delete Paragraph 5.06A. of the General Conditions in its entirety and replace with the following:

A. Contractor shall purchase and maintain property insurance upon the Work at the site on a replacement cost basis with a limit not less than 100% of the Project's replacement value thereof (subject to such deductible amounts as may be provided in these Supplementary Conditions or required by Laws and Regulations). This limit should include "soft cost," or expenses relating to the construction project(s) over and above those costs which would have been incurred if there had been no loss. These soft costs should include; but not be limited to, interest, additional taxes, advertising/promotional expenses, additional commissions, loss of rents, architects, or engineering fees. This insurance shall

1. include the interests of Owner, Contractor, Subcontractors, Engineer, Engineer's Consultants and any other persons or entities identified in Paragraph 5.04B.1 of these Supplementary Conditions, each of whom shall 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 and damage to the Work, temporary buildings, false work, and Work in transit and shall insure against at least the following perils; fire, lightening, extended coverage, theft, vandalism and malicious mischief, earthquake, collapse, debris removal, demolition occasioned by enforcement of Laws and Regulations, water damage, and such other 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 in transit to the Project site, and materials that the Contractor has taken possession of whether stored at the Project site;
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 make unless otherwise agreed to in writing by the Owner, Contractor, and Engineer with thirty days written notice to each other additional insured to whom a certificate of insurance has been issued.

The polices of insurance required to be purchased and maintained by Contractor in accordance with Paragraph 5.06A shall comply with the requirements of Paragraph 5.06C.

Delete Paragraph 5.06B. of the General Conditions in its entirety and replace with the following:

B. Contractor shall purchase and maintain such equipment breakdown 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 persons or entities identified in Paragraph 5.04B.1. of these Supplementary Conditions, each of whom is deemed to have an insurable interest and shall be listed as an insured or additional insured.

SC-5.06C.

Delete Paragraph 5.06C. of the General Conditions in its entirety and replace with the following:

C. All the policies of insurance (or the certificates or other evidence thereof) required to be purchased and maintained by Contractor in accordance with paragraphs 5.06A. and 5.06B. (1) shall contain a provision or

endorsement that the coverage afforded will not be canceled or materially changed or renewal refused until at least thirty days' prior written notice has been given to Owner, Engineer and each other loss payee by certified mail, (2) shall contain provisions to the effect that the insurer(s) waiver all rights of subrogation against the Owner, Engineer and their officers, directors, partners, employees and other consultants and subcontractors of each and any of them.

SC-5.06D.

Delete Paragraph 5.06D of the General Conditions in its entirety and replace with the following:

D. Owner shall not be responsible for purchasing and maintaining any insurance to protect the interest of the Contractor, Subcontractor, or others in the Work. The stated limits of insurance required are minimum only. Contractor shall determine the limits that are adequate. These limits may be basic policy limits or any combination of basic limits and umbrella limits. In any event, Contractor is fully responsible for all losses arising out of, resulting from or connected with operations under this contract whether or not said losses are covered by insurance. The acceptance of certificates or other evidence of insurance by the Owner, Engineer, and/or other listed as additional insured in Paragraph 5.04B.1. that in any respect do not comply with the Contract requirements does not release the Contractor form compliance herewith.

SC-5.06E

Delete Paragraph 5.06E of the General Conditions in its entirety.

SC-5.07A.

Delete paragraph 5.07A. of the General Conditions in its entirety and replace with the following.

A. All insurance policies provided by the Contractor shall contain provisions to the effect that the insurer waives all rights of subrogation against any of the insured, loss payee, (and the officers, directors, members, partners, employees, agents, consultants and subcontractors of each and any of them) Owner and the Engineer.

SC-5.08A.

Delete paragraph 5.08A. of the General Conditions in its entirety.

SC-5.08B.

Delete paragraph 5.08B. of the General Conditions in its entirety.

SC-5.09A.

Delete paragraph 5.09A. of the General Conditions in its entirety and replace with the following:

A. If Owner has any objection to the coverage afforded by or other provisions of the insurance required to be purchased and maintained by Contractor in accordance with this Article 5 on the basis of its not complying with the Contract Documents, Owner will notify Contractor in writing thereof within ten days of the date of delivery of such certificates to Owner in accordance with paragraph 2.01. Contractor will provide such additional information in respect of insurance provided by Contractor as Owner may reasonably request.

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ARTICLE 6 - CONTRACTOR'S RESPONSIBILITIES

SC-6.02B.

Add the following new paragraphs immediately after paragraph 6.02B. of the General Conditions which are to read as follows:

C. Regular working hours are defined as 10 hours per day, Monday through Friday, excluding holidays, between the hours of 7:00 AM and 6:00 PM. Requests to work other than regular working hours shall be submitted to Engineer not less than 48 hours prior to any proposed weekend work or scheduled extended work weeks. Occasional unscheduled overtime on weekdays may be permitted provided two hours notice is given to Engineer.

D. Contractor shall reimburse the Owner for additional engineering and/or inspection costs incurred as a result of overtime work in excess of the regular working hours stipulated in Article SC-6.02C. At Owner's option, overtime costs may either be deducted from the Contractor's monthly payment request or deducted from the Contractor's retention prior to release of final payment. Overtime costs for the Owner's personnel shall be based on the individual's current overtime wage rate. Overtime costs for personnel employed by the Engineer or Owner's independent testing laboratory shall be calculated in accordance with the terms of their respective contracts with the Owner.

SC-6.03B.

Add the following new paragraphs immediately after paragraph 6.03B. of the General Conditions which are to read as follows:

C. This Agreement is subject to the applicable provisions of the Contract Work Hours and Safety Standards Act, Public Law 87-581, 87th Congress. No Contractor or Subcontractor contracting for any part of the Work shall require or permit any laborer or mechanic to be employed on the Work in excess of forty hours in any work week unless such laborer or mechanic receives compensation at a rate not less than one and one-half times that person's basic rate of pay for all hours worked in excess of forty hours in such work week.

D. Contractor shall employ only competent persons to do the work and whenever Owner shall notify Contractor, in writing, that any person on the Work appears to be incompetent, disorderly, or otherwise unsatisfactory, such person shall be removed from the Project and shall not again be employed on it except with the consent of Owner.

E. Contractor and Subcontractors shall, insofar as practicable, give preference in the hiring of workers for the Project to qualified local residents with first preference being given to citizens of the United States who have served in the armed forces of the United States and have been honorably discharged therefrom or released from active duty therein.

F. Except as may be otherwise required by law, all claims and disputes pertaining to the classification of labor employed on the project under this Contract shall be decided by the governing body having jurisdiction.

G. Contractor and all Subcontractors shall comply with the Regulations of the Secretary of Labor made pursuant to the Anti-Kickback Act of June 30, 1940 (40 U.S.C. 276c) and all amendments or modifications thereto. Contractor and all Subcontractors shall furnish Owner with weekly Statements of

Compliance. In case of Subcontracts, Contractor shall cause appropriate provision to be inserted in all subcontracts for the Work which Contractor may let to ensure compliance with said Anti-Kickback Act by all Subcontractors subject thereto, and Contractor shall be responsible for the submission of all Statements of Compliance required of Subcontractors by said Anti-Kickback Act except as the Secretary of Labor may specifically provide for reasonable limitations, variations, and exemptions from the requirements thereof. These Regulations are part of this Contract and are included in PART II of these Supplementary Conditions.

H. Contractor and Subcontractors shall, insofar as practicable, give preference in the hiring of workers for the Project to qualified local residents with first preference being given to citizens of the United States who have served in the armed forces of the United States and have been honorably discharged therefrom or released from active duty therein.

SC-6.05A.

Delete Paragraph 6.05A. of the General Conditions in its entirety and replace with the following:

6.05 *Substitutes and "Or Equals"*

A. Where equipment and products are specified by name, no substitutions or "or-equals" will be considered or approved unless the term "or-equal" is included in the acceptable manufacturer section of the Specifications

1. If substitutes or "or-equals" are specifically permitted for consideration by the individual Specifications, they must be submitted and will be reviewed and evaluated in accordance with the provisions established in General Condition Paragraph 6.05 and in Division 1 of the Specifications. Any determination made by the Engineer is subject to the review and approval by the Owner and the Owner's determination shall be final.

SC-6.05C.

Amend Paragraph 6.05C. by deleting the third sentence and replacing it with the following:

No "or-equals" or substitutes will be ordered, installed or utilized until Engineer's review is complete, which will be evidenced by either a Change Order or Field Order.

SC-6.05E.

Amend Paragraph 6.05E. by changing the reference in the first sentence from 6.05A.2. to 6.05A.

Amend Paragraph 6.05E. by deleting the work "substitute" in all locations and replacing it with the phrase "substitute or "or-equal"".

SC-6.06A.

Delete Paragraphs 6.06A. and 6.06B. of the General Conditions in their entirety and replace with the following:

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A. Contractor shall not employ any Subcontractor, Supplier or other person or organization, (including those who are to furnish the principal items of materials or equipment), whether initially or as a substitute, against whom Owner may have reasonable objection. Acceptance of any Subcontractor, other person or organization by Owner shall not constitute a waiver of any right of Owner to reject defective Work. Contractor shall not be required to employ any Subcontractor, other person or organization against whom Contractor has reasonable objection.

B. Not Used.

SC-6.06E.

Add the following new sentence at the end of paragraph 6.06E. of the General Conditions to read as follows:

Owner or Engineer may furnish to any such Subcontractor, Supplier or other person or organization, to the extent practicable, information about amounts paid on their behalf to Contractor in accordance with Contractor's Applications for Payment.

SC-6.07B

Delete paragraph 6.07B of the General Conditions in its entirety.

SC-6.16A.

Delete the last sentence in paragraph 6.16A. of the General Conditions in its entirety and replace with the following:

If Engineer determines that the incident giving rise to the emergency action was not the responsibility of the Contractor and that a change in the Contract Document is required because of the action taken by the Contractor in response to such an emergency, a Work Change Directive or Change Order will be issued.

SC-6.17E.1.

Delete the last sentence in Paragraph 6.17E.1. and replace with the following:

All resubmittals shall be in strict compliance with the Drawings, Specifications and Contract Documents, and only the changes permitted from the prior submittal shall be modifications or additional information addressing specifically the Engineer's previous comments.

SC-6.17E.1.

Add a new sentence at the end of Paragraph 6.17.E.1 to read as follows:

Approval of Shop Drawings for equipment requiring Efficiency Guarantee Bonds will be withheld until the receipt of such Bonds.

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SC-6.18A.

Amend Paragraph 6.18A. of the General Conditions by adding the following at the end of the second sentence:

CONTRACTOR assumes and bears responsibility for all costs and time delays associated with any variation from the requirements of the Contract Documents.

SC-6.19C

Add the following new paragraph immediately after paragraph 6.19 C which is to read as follows:

D. Manufacturer's Guaranty/Warranty

1. The Contractor shall obtain the following guaranty/warranty from the manufacturer of all major pieces of equipment furnished and installed on this Project. Such guaranty/warranty shall be for the benefit of Owner and be furnished in writing by the manufacturer. The Contractor's and manufacturer's obligations under this provision are in addition to other express or implied warranties under the Contract Documents and under the law and in no way diminish any other right that the Owner may have against the Contractor or manufacturer for faulty material, equipment or work. The warranty period shall not be interpreted as a limitation on the time in which the Owner can enforce such other duties, obligations, rights, or remedies.

2. The manufacturer warrants and guarantees for a period of one year from the date of Substantial Completion, or such longer period that may be specified in the Contract Documents, that all materials and equipment furnished and installed shall be free from flaws, defects in material and workmanship and shall be in conformance with the Contract Documents.

SC-6.20A.

Delete paragraph 6.20A. of the General Conditions in its entirety and replace with the following:

A. To the fullest extent permitted by Laws and Regulations, Contractor shall defend, indemnify and hold harmless Owner, Engineer and the officers, directors, members, partners, employees, agents, consultants and subcontractors of each and any of them from and against all claims, costs, losses and damages (including but not limited to all fees and charges of engineers, architects, attorneys and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to the performance of the Work, provided that any such claim, cost or 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 of 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 indemnified party unless caused by the sole negligence of a party indemnified hereunder.. If through the acts of neglect on the part of Contractor, any other contractor or any Subcontractor shall suffer loss or damage on the Work, Contractor shall settle with such other contractor or Subcontractor by agreement or arbitration if such other contractor or Subcontractor will so settle. If such other contractor or Subcontractor

shall assert any claim against Owner and/or Engineer, or the officers, directors, members, partners, employees, agents, consultants and subcontractors of each on account of any damage alleged to have been sustained, Owner shall notify Contractor, who shall indemnify and save harmless Owner, Engineer, and the officers, directors, members, partners, employees, agents, consultants and subcontractors of each against any such claims.

SC-6.21E

Delete paragraph 6.21E of the General Conditions in its entirety and replace with the following:

E. Contractor shall not be responsible for the adequacy of the performance criteria or design criteria contained in the Contract Documents.

ARTICLE 8. OWNER'S RESPONSIBILITIES

SC-8.01

Delete Paragraph 8.01 of the General Conditions in its entirety and replace it with the following:

8.01 *Communications to Contractor*

A. Owner will issue project communications related to the administration of the Construction Contract through the Engineer.

SC-8.02.A.

Delete Paragraph 8.02A. of the General Conditions in its entirety and replace it with the following:

A. In the case of termination of the employment of the Engineer, Owner will notify the Contractor of their intent to appoint a different engineer to the Project. Contractor may voice any objections with regard to the Owner's replacement engineer within a reasonable time set by the Owner and Owner will take these objections (if any) into consideration before appointing the new engineer.

SC-8.06

Delete paragraph 8.06 of the General Conditions in its entirety.

SC-8.09A.

Amend Paragraph 8.09A. of the General Conditions by adding the following at the end of the second sentence:

Any failure or neglect on the part of Owner, or Engineer to enforce provisions herein dealing with supervision, control, inspection, testing or acceptance and approval of the Work shall never operate to relieve Contractor from full compliance with the Contract Documents nor render Owner liable to Contractor for money damages, extensions of time or increased compensation of any kind.

SC-8.10.

Delete Paragraph 8.10 in its entirety.

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ARTICLE 9 - ENGINEER'S STATUS DURING CONSTRUCTION

SC-9.01

Delete Paragraph 9.01 of the General Conditions in its entirety and replace with the following:

*9.01 Authority of ENGINEER*

A. Engineer is the Owner's representative during the construction period. However, any determination made by the Engineer is subject to the review and approval of the Owner and the Owner's determination shall be final.

SC-9.03A.

Add the following new paragraph immediately after paragraph 9.03A. of the General Conditions which is to read as follows:
B. Engineer will furnish a Resident Project Representative and assistants to assist Engineer in observing the performance of the Work. The duties and responsibilities of the Resident Project Representative will be as enumerated in a document entitled "Duties, Responsibilities and Limitations of the Authority of Resident Project Representative" and will be made available to Contractor at the start of the Work.

SC-9.04.

Delete Paragraph 9.04 of the General Conditions in its entirety and replace with the following:

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.

SC-9.05.

Delete Paragraph 9.05 of the General Conditions in its entirety and replace with the following:

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. The Contractor shall notify the Engineer in writing prior to beginning any Work addressed in a Field Order if the Contractor does not agree that the Work involved represents no additional cost and/or time change in the Contract Documents.

SC-9.07

Delete Paragraph 9.07 of the General Conditions in its entirety and replace with the following:

9.07 *Determination 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 is subject to the review and approval of the Owner and the Owner's determination shall be final as provided in 9.01A.

SC-9.08.

Delete Paragraph 9.08 of the General Conditions in its entirety and replace with the following:

9.08 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. Engineer's formal decision thereon is subject to the review and approval of the Owner and the Owner's determination shall be final as provided by Paragraph 9.01A.

B. The rendering of a decision by Engineer pursuant to this Paragraph 9.09 and the review and final decision by Owner thereof, with respect to any such claim, dispute or other matter (except any which have been waived by the acceptance of final payment as provided in Paragraph 14.07) will be a condition precedent to any exercise by Contractor of any rights or remedies it may otherwise have under the Contract Documents or by Laws and Regulation in respect to any such claim, dispute or other matter.

ARTICLE 10 – CHANGES IN THE WORK; CLAIMS

SC-10.05

Delete Paragraph 10.05 of the General Conditions in its entirety and replace with the following:

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 promptly (but in no event later than 7 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 within 30 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.

B. Engineer will issue a written recommendation to the Owner in writing within 30 days after receipt of the last submittal of the claimant or the last submittal of the opposing party, if any.

C. If Engineer does not issue a written recommendation 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; ALLOWANCES; UNIT PRICE WORK

SC-11.01A.

Amend Paragraph 11.01 A. of the General Conditions by striking out the following words in the third sentence: "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." and adding the following:

"those paid for the Work included in the Contract Price, shall include only the following items, and shall not include any of the costs itemized in paragraph 11.01 B. Contractor shall provide certified payroll records listing personnel classifications and salaries for all individuals involved in additional Work. Salaries for those not included in the certified payroll will be considered as being compensated under paragraph 11.01 B.".

SC-11.01A.1.

Delete the second sentence in paragraph 11.01A.1. of the General Conditions in its entirety and replace with the following:

Such employees shall include one foremen (unless agreed upon prior to beginning Work).

Amend paragraph 11.01 A.1 of the General Conditions by striking out the following words in the last sentence: "be included in the above" and adding the following:

"not exceed 1.5 times regular pay and shall be included in the above"

SC-11.01B.1.

Amend Paragraph 11.01B.1. by adding the following to the list of excluded personnel in the first sentence:

Superintendents

SC-11.01D.

Amend Paragraph 11.01D. by modifying the sentence to read as follows:

"...and submit in a form and at intervals acceptable to Engineer..."

SC-11.02A.

Delete paragraphs 11.02A. through D. of the General Conditions in their entirety.

SC-11.03D.

Delete paragraph 11.03D. of the General Conditions in its entirety and replace with the following:

D. The unit price of an item of Unit Price Work shall be subject to re-evaluation and adjustment under the following conditions:

1. if the total cost of a particular item of Unit Price Work amounts to 20 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 20 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 Unit Price for that quantity by which the actual quantity exceeds 115% of the estimated quantity in accordance with Article 10.05 if the parties are unable to agree as to the effect of any such variations in the quantity of Unit Price Work performed.

SC-11.03

Add new paragraph following Paragraph 11.03 of the General Conditions which is to read as follows:

11.04 *No Claims for Delays*

A. The Contractor agrees to make no claims for damage for delay in the performance of the Contract occasioned by any act or omission to act of the Owner, Engineer, or any of the Engineer's or Owner's agents, and agrees that any such claim shall be fully compensated by an extension of time, as set forth in a Change Order, to complete performance of the work as provided herein.

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

SC-12.01A.

Delete Paragraph 12.01 A. of the General Conditions in its entirety and replace with the following:

A. The Contract Price may only be changed by a Change Order or Written Amendment. Any claim by Contractor for an adjustment in the Contract Price shall be in writing to the Engineer and will be processed in accordance with Article 10 hereof.

SC-12.01B.2.

Delete Paragraph 12.01.B.2. of the General Conditions in its entirety.

SC-12.01C.2.b.

In the second line of paragraph 12.01C.2.b., before the semicolon add the following words "based on subcontractor's Cost of the Work";

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SC-12.02A.

Delete Paragraph 12.02A. of the General Conditions in its entirety and replace with the following:

A. The Contract Times (or Milestones) may only be changed by a Change Order or Written Amendment which shall be processed in accordance with Article 10 hereof.

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

13.04 *Uncovering Work*

A. If any Work is covered contrary to the request of Engineer, it must, if requested by Engineer, be uncovered for Engineer's observation and replaced at Contractor's expense.

B. In circumstances different from 13.04 A above, if Engineer considers it necessary or advisable that covered Work be observed by the 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.

SC-13.05A.

Add the following new paragraph immediately after paragraph 13.05A. of the General Conditions to read as follows:

B. If Owner stops Work under Paragraph 13.05A., Contractor shall be entitled to no extension of Contract Time or increase in Contract Price.

SC-13.07A.

Add a new paragraph immediately after Paragraph 13.07 A of the General Conditions to read as follows:

When early acceptance of a Substantially Completed portion of the Work is accomplished in the manner indicated, the correction period for that portion of the Work shall commence at the time of substantial completion of that Work.

SC-13.08A.

Delete Paragraph 13.08 A. of the General Conditions in its entirety replace with the following:

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.

SC-13.09C.

Delete Paragraph 13.09C. of the General Conditions in its entirety and replace with the following:

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. 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.

ARTICLE 14 - PAYMENTS TO Contractor AND COMPLETION

SC-14.02A.3.

Delete Paragraph 14.02 A.3. of the General Conditions in its entirety and replace with the following:

3. The amount of retainage with respect to progress payments will be ten percent (10%) of the total amount of completed Work up to the point that the Engineer certifies that the project is 50% complete. Retainage on completed work will not be withheld thereafter. Retainage will not be withheld on materials that are property stored and protected.

Add a new paragraph immediately after paragraph 14.02A.3 of the General Conditions which is to read as follows:

4. Contractor shall furnish evidence that payment received on the basis of materials and equipment not incorporated and suitably stored, has in fact been paid to the respective supplier(s) within sixty days of payment by Owner. Failure to provide such evidence of payment may result in the withdrawal of previous approval(s) and removal of the cost of related materials and equipment from the next submitted Application for Payment.

SC-14.02B.5

Revise the first sentence in paragraph 14.02B.5 to read as follows:

5. Engineer may refuse to recommend the whole or any part of any payment if the established Contract Time for Substantial Completion has expired, or if in the Engineer's opinion, it would be incorrect to make the representation to the Owner state in Paragraph 14.02B.2.

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SC-14.02C.1.

In paragraph 14.02C.1. of the General Conditions delete the word "Ten" and replace with the word "thirty".

SC-14.02C.1.

Add the following new paragraphs immediately after paragraph 14.02C.1. of the General Conditions which are to read as follows:

2. Should Contractor neglect to pay any undisputed claims, made in writing to Owner within thirty days after completion of the Work, but continuing unsatisfied for a period of ninety days, Owner may pay such claim and deduct the amount thereof from the balance due Contractor. Owner may also, with the written consent of Contractor, use any monies retained, due, or to become due under this Contract for the purpose of paying for both labor and materials for the Work, for which claims have not been filed.

3. Security is provided both by the Payment Bond and the power of Owner to retain any monies for claims, but payment by one shall in no way impair or discharge the liability of the other.

4. Any and all liens for work and materials may be paid off by Owner within a reasonable time after filing for record in accordance with State and local laws, a notice of such liens except where the claim on which the lien is filed is being litigated by Contractor, and in such case Owner may pay the amount of any final judgment or decree or any such claim within a reasonable time after such final judgment or decree shall be rendered.

5. All monies paid by Owner in settlement of liens as aforesaid, with the costs and expenses incurred by Owner in connection therewith, shall be charged to Contractor, shall bear interest at the rate of three percentage points above the rediscount rate then charged by the Federal Reserve Bank, and shall be deducted from the next payment due Contractor under the terms of this Contract.
SC-14.03A.

Add the following new paragraphs immediately after paragraph 14.03A. of the General Conditions which are to read as follows:

B. No materials or supplies for the Work shall be purchased by Contractor or Subcontractor subject to any chattel mortgage or under a conditional sale contract or other agreement by which an interest is retained by the seller. Contractor warrants that Contractor has good title to all materials and supplies used by Contractor in the Work, free from all liens, claims or encumbrances.

C. Contractor shall defend, indemnify and save Owner and Engineer harmless from all claims growing out of the lawful demands of Subcontractors, laborers, workmen, mechanics, materialmen, and furnishers of machinery and parts thereof, equipment, power tools, and all supplies, including commissary, incurred in the furtherance of the performance of this Contract. Contractor shall at Owner's request, furnish satisfactory evidence that all obligations of the nature hereinabove designated have been paid, discharged, or waived. If Contractor fails to do so, then Owner may, after having served written notice on the said Contractor either pay unpaid bills, of which Owner has written notice, direct, or withhold from the Contractor's unpaid compensation a sum of money deemed reasonably sufficient to pay any and all such lawful claims until satisfactory evidence is furnished that all liabilities have been fully discharged whereupon payment to Contractor shall be resumed, in accordance with the terms of this Contract, but in no event shall the provisions of this sentence be construed to impose any obligations upon Owner to either

Contractor or Contractor's Surety. In paying any unpaid bills of the Contractor, Owner shall be deemed the agent of Contractor and any payment so made by Owner shall be considered as payment made under the Contract by Owner to Contractor and Owner shall not be liable to Contractor for any such payment made in good faith.

SC-14.02D.1.

Delete 14.02 D. 1. d. Add new paragraphs immediately after Paragraph 14.02 D.1.c. of the General Conditions which are to read as follows:

d. Owner has been notified of Contractor's failure to make payments to Subcontractors or Suppliers or for labor;

e. Contractor's failure to submit up-to-date record documents as required by GC-6.12;

f. Contractor's failure to submit monthly progress schedule updates or revised schedules as requested by the Owner or Engineer;

g. Contractor's failure to provide Project photographs required by Specifications;

h. Unsatisfactory progress of the work not caused by conditions beyond the Contractor's control;

i. Contractor's failure to carry out instructions of the Owner or his representative;

j. Owner has a reasonable doubt that the contract can be completed for the balance then unpaid;

k. Damage to another contractor;

l. Claim filed by or against Contractor or reasonable evidence indicating probable filing of claims; or

m. 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.l or paragraph 15.02.A.

SC-14.02D.3.

Add a new paragraph immediately after Paragraph 14.02D.3. of the General Conditions which is to read as follows:

4. Owner may permanently withhold payment from Contract Price for

a. liquidated damages incurred by Contractor, or

b. compensation for Engineer for overtime charges of Resident Project Representative, third and subsequent reviews of submittals, review of substitutions, re-inspection fees, inspections or designs related to correction

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of defective Work, or other Services identified as requiring payment by the Contractor. Compensation will be based on the following rates:

| Position | Hourly Rate |
|---|---|
| Officer of the Firm | $300.00 |
| Principal in Charge/ Project Manager | $255.00 |
| Project Engineer | $140.00 |
| Resident Project Representative | $125.00 |
| Design Engineer | $120.00 |
| Technician | $85.00 |
| Clerk | $65.00 |
| Other Direct Costs will be billed at the actual cost multiplied by 1.15. | |

c. Costs for tests performed by the Owner to verify that work previously tested and found to be defective has been corrected. Verification testing is to be provided at the Contractor's expense to verify products or constructed works are in compliance after corrections have been made.

SC-14.03A.

Add two new paragraphs immediately after Paragraph 14.03A of the General Conditions which are to read as follows:

B. No materials or supplies for the Work shall be purchased by Contractor or Subcontractor subject to any chattel mortgage or under a conditional sale contract or other agreement by which an interest is retained by the seller. Contractor warrants that Contractor has good title to all materials and supplies used by Contractor in the Work, free from all liens, claims or encumbrances.

C. Contractor shall indemnify and save Owner harmless from all claims growing out of the lawful demands of Subcontractors, laborers, workmen, mechanics, materialmen, and furnishers of machinery and parts thereof, equipment, power tools, and all supplies, including commissary, incurred in the furtherance of the performance of this Contract. Contractor shall at Owner's request, furnish satisfactory evidence that all obligations of the nature hereinabove designated have been paid, discharged, or waived. If Contractor fails to do so, then Owner may, after having served written notice on the said Contractor either pay unpaid bills, of which Owner has written notice, direct, or withhold from the Contractor's unpaid compensation a sum of money deemed reasonably sufficient to pay any and all such lawful claims until satisfactory evidence is furnished that all liabilities have been fully discharged whereupon payment to Contractor shall be resumed, in accordance with the terms of this Contract, but in no event shall the provisions of this sentence be construed to impose any obligations upon Owner to either Contractor or Contractor's Surety. In paying any unpaid bills of the Contractor, Owner shall be deemed the agent of Contractor and any payment so made by Owner, shall be considered as payment made under the Contract by Owner to Contractor and Owner shall not be liable to Contractor for any such payment made in good faith.

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SC-14.04

Delete Paragraph 14.04 of the General Conditions in its entirety and replace with the following:

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 therefore. 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 will thereafter review the tentative certificate of Substantial Completion and make a final determination as to substantial completion which will be communicated to the Contractor in writing within 20 days after receipt of the tentative certificate.

SC-14.06A

Add the following sentences after the second sentence of paragraph 14.06A:

> If, after such measures are taken, subsequent inspections by Engineer reveal that any of the previously identified particulars remain incomplete or defective, Engineer will again notify Contractor in writing of the remaining particulars. All costs associated with any subsequent inspections in which said remaining particulars are revealed, will be documented by Engineer and paid by Contractor to Owner.

SC-14.07B.1.

Delete paragraph 14.07B.1. of the General Conditions in its entirety and replace with the following:

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 - all 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 indicate in writing Engineer's recommendation of payment and present the Application to Owner for payment. Thereupon Engineer will 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 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. If the Application and accompanying documentation are appropriate as to form and substance, Owner shall in accordance with the applicable State or local General Law, pay Contractor the amount recommended by Engineer.

SC-14.07C.

Add a new paragraph immediately after Paragraph 14.07C. of the General Conditions which is to read as follows:

D. In the event the Contractor fails to attain Substantial Completion of the entire Project (all bid items) within the Contract Time, the Owner may withhold money permanently from the Contractor's total

compensation a sum of $1,000 per day as liquidated damages and for added expenses including engineering services, etc. In the event the Contractor fails to attain Final Completion of the entire Project (all bid items) within the Contract Time, the Owner may withhold money permanently from the Contractor's total compensation a sum of $500 per day as liquidated damages and for added expenses including engineering services, etc. The Owner will be the sole judge as to whether the work has been completed within the allotted time. Accordingly, it is agreed and understood that said amount is to be assessed by the Owner, not as a penalty, but as a predetermined and agreed upon liquidated damage. Additionally, assessment of liquidated damages by the Owner shall not constitute a waiver of the Owner's right to sue and collect additional damages which Owner may sustain by the failure of the Contractor to perform in accordance with the terms of its Contract.

SC-14.08A.

Delete Paragraph 14.08. of the General Conditions in its entirety and replace with the following:

A. If after Substantial Completion of the Work final completion thereof is materially delayed though no fault of the Contractor, and the Engineer so confirms, Owner, upon certification by Engineer, and without terminating the Agreement, may make payment of all or a portion of the balance due for that portion of the Work fully completed and accepted. If the remaining balance for the 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 payment of the balance due for that portion of the Work fully completed and accepted shall be submitted by the Contractor to Engineer prior to certifications of such payment. Such payment, if approved, shall be made under the terms and conditions governing final payment, except that it shall not constitute a waiver of claims.

SC-14.09

Delete Paragraph 14.09. of the General Conditions in its entirety and replace with the following:

14.09 *Waiver of Claims*

A. The acceptance of final payment by the Contractor shall constitute a waiver of all claims by Contractor against Owner.

ARTICLE 15 - SUSPENSION OF WORK AND TERMINATION

SC-15.01

Delete Paragraph 15.01 of the General Conditions in its entirety and replace with the following:

15.01 *Owner's Right to Temporarily Suspend Work* .

A. Reasons for Suspension. The Owner shall have the right by written order to temporarily suspend the work, in whole or in part, whenever, in the judgment of the Owner, such temporary suspension is required:

1. in the interest of the Owner generally,
2. due to government or judicial controls or orders which make performance of this contract temporarily impossible or illegal,
3. to coordinate the work of separate contractors at the job site,

4. to expedite the completion of a separate contract even though the completion of this particular contract may be thereby delayed,
5. because of weather conditions unsuitable for performance of the work, or
6. because the Contractor is proceeding contrary to contract provisions or has failed to correct conditions considered unsafe for workmen.

B. The written order of the Owner to the Contractor shall state the reasons for suspending the work and the anticipated periods for such suspension. Upon receipt of the Owner's written order, the Contractor shall suspend the work covered by the order and shall take such means and precautions as may be necessary to properly protect the finished and partially finished work, the unused materials and uninstalled equipment, including the providing of suitable drainage about the work and erection of temporary structures where necessary. The Contractor shall not suspend the work without written direction from the Engineer and shall proceed with the work promptly when notified by the Engineer to resume operations.

C. No additional compensation shall be paid to the Contractor for such suspension under Paragraph 15.01 A.6. above or otherwise where same is caused by the fault of the Contractor. Where such temporary suspension is not due to the fault of the Contractor, he shall be entitled to:

1. An equitable extension of working time for the completion of the work, not to exceed the delay caused by such temporary suspension, as determined by the Owner; and
2. the actual and necessary costs of properly protecting the finished and partially finished work, unused materials and uninstalled equipment during the period of the ordered suspension as determined by the Owner as being beyond the contract requirements, such costs, if any, to be determined on the basis set forth in Article 12 of the General Conditions, and
3. where the Contractor elects to move equipment from the job site and then return it to the site when the work is ordered resumed, the actual and necessary costs of these moves, in an amount determined by the Owner under the provisions of Article 12 of the General Conditions

SC-15.02.

Delete Paragraph 15.02 of the General Conditions in its entirety and replace with the following:

15.02 *Contractor Default: Owner's Right to Suspend Work and Annul Contract*

A. The work or any portion of the work under contract shall be suspended immediately on written order of the Owner declaring the Contractor to be in default. A copy of such notice shall be served on the Contractor's surety. The contract may be annulled by the Owner for any good cause or causes, among others of which special reference is made to the following:

1. failure of the Contractor to start the work within 10 days from date specified in the written work order issued by the Owner to begin the work;
2. substantial evidence that the progress of the work being made by the Contractor is insufficient to complete the work within the specified working time;
3. failure of the Contractor to provide sufficient and proper equipment, materials or construction forces for properly executing the work;
4. substantial evidence that the Contractor has abandoned the work or discontinuance of the performance of the work or any part thereof and failure to resume performance within a reasonable time after notice to do so;
5. substantial evidence that the Contractor has become insolvent or bankrupt, or otherwise financially unable to carry on the work;
6. deliberate failure on the part of the Contractor to observe any requirements of these specifications or to comply with any orders given by the Engineer as provided for in these specifications;

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7. failure of the Contractor to promptly make good any defects in materials or workmanship, or any defects of any nature, the correction of which has been directed in writing by the Owner;
8. substantial evidence of collusion for the purpose of illegally procuring a contract or perpetrating fraud on the Owner in the construction of work under contract;
9. repeated and flagrant violations of safe working procedures;
10. the filing by the Contractor of litigation against the Owner prior to final completion of the work.

B. When the work is suspended for any of the causes itemized above, or for any other cause or causes, the Contractor shall discontinue the work or such part thereof as the Owner shall designate, whereupon the surety may either at its option assume the contract or that portion thereof which the Owner has ordered the Contractor to discontinue and perform the same or, with the written consent of the Owner, sublet the same, provided, however, that the surety shall exercise its option within two weeks after the written notice to discontinue the work has been served upon the Contractor and upon the surety or its authorized agents. The surety in such event shall assume the Contractor's place in all respects and shall be paid by the Owner for all work performed by it in accordance with the terms of the contract, but in no event shall such payments exceed the contract amount, regardless of the cost to the surety to complete the work.

All monies remaining due the Contractor at the time of his default shall thereupon become due and payable to the surety as the work progresses, subject to all terms of the contract. In case the surety does not, within the hereinabove specified time, exercise its obligation to assume the contract or that portion thereof which the Owner has ordered the Contractor to discontinue, then the Owner shall have the power to complete by contract or otherwise, as it may determine, the work herein described or such part thereof as it may deem necessary; and the Contractor hereto agrees that the Owner shall have the right to take possession of or use any or all of the materials, plant, tools, equipment, supplies and property of every kind provided by the Contractor for the purpose of his work and to procure other tools, equipment and materials for the completion of the same and to charge to the account of the Contractor the expense of said contract for labor, materials, tools, equipment and expenses incident thereto. The expense so charged shall be deducted by the Owner out of such monies as may be due or may at any time thereafter become due the Contractor under and by virtue of the contract or any part thereof.

C. The Owner shall not be required to obtain the lowest bid for the work of completing the contract, but the expenses to be deducted shall be the actual cost of such work. In case such expense is less than the sum which would have been payable under the contract if the same had been completed by the Contractor, then in such case the Owner may pay the Contractor the difference in the cost, provided that the Contractor shall not be entitled to any claim for damages or for loss of anticipated profits.

D. In case such expense shall exceed the amount which would have been payable under the contract if the same had been completed by the Contractor, the Contractor and his surety shall pay the amount of the excess to the Owner on notice from the Owner for excess due including any costs incurred by the Owner, such as inspection, legal fees and liquidated damages. When any particular part of the work is being carried on by the Owner by contract or otherwise under the provisions of this section, the Contractor shall continue the remainder of the work in conformity with the terms of the contract and in such a manner as not to hinder or interfere with the performance of workmen employed as above provided by the Owner or surety.

SC-15.02A.4.

Add the following new paragraph immediately after paragraph 15.02A.4. of the General Conditions which is to read as follows:

5. if Contractor abandons the Work, or sublets this Contract or any part thereof, without the previous written consent of Owner, or if the Contract or any claim thereunder shall be assigned by Contractor otherwise than as herein specified;

SC-15.03

Delete Paragraph 15.03 of the General Conditions in its entirety and replace with the following:

15.03 *Termination for Convenience of the Owner*

A. The performance of the work under this contract may be terminated by the Owner in whole or from time to time in part, in accordance with this section, whenever the OWNER shall determine that such termination is in the best interest of the Owner. Any such termination shall be effected by mailing a notice of termination to the Contractor specifying the extent to which performance of work under the contract is terminated, and the date upon which such termination becomes effective. Receipt of the notice shall be deemed conclusively presumed and established when the letter is placed in the United States Mail by the Owner. Further, it shall be deemed conclusively presumed and established that such termination is made with just cause as therein stated; and no proof in any claim, demand or suit shall be required of the Owner regarding such discretionary action.

B. After receipt of a notice of termination, and except as otherwise directed by the Engineer, the Contractor shall:

1. stop work under the contract on the date and to the extent specified in the notice of termination;
2. place no further orders or subcontracts for materials, services or facilities except as may be necessary for completion of such portion the work under the contract as is not terminated;
3. terminate all orders and subcontract to the extent that they relate to the performance of work terminated by the notice of termination;
4. transfer title to the Owner and deliver in the manner, at the times, and to the extent, if any, directed by the Engineer:
   a. the fabricated or un-fabricated parts, work in process, completed work, supplies and other material produced as a part of, or acquired in connection with the performance of, the work terminated by the notice of termination; and
   b. the completed or partially completed plans, drawings, information and other property which, if the contract had been completed, would have been required to be furnished to the Owner.
5. complete performance of such part of the work as shall not have been terminated by the notice of termination; and
6. take such action as may be necessary, or as the Engineer may direct, for the protection and preservation of the property related to its contract which is in the possession of the Contractor and in which the Owner has or may acquire an interest. At a time not later than 30 days after the termination date specified in the notice of termination, the Contractor may submit to the Engineer a list, certified as to the quantity and quality, of any or all items of termination inventory not previously disposed of, exclusive of items the disposition of which has been directed or authorized by the Engineer. Not later than 15 days thereafter, the Owner shall accept title to such items and remove them or enter into a storage agreement covering the same, provided that the list submitted shall be subject to verification by the Engineer upon removal of the items, or, if the items are stored, within 45 days from the date of submission of the list, and provided that any necessary adjustments to correct the list as submitted shall be made prior to final settlement.

C. Within 60 days after notice of termination, the Contractor shall submit his termination claim to the Engineer in the form and with the certification prescribed by the Engineer. Unless one or more extensions in

writing are granted by the Engineer upon request of the Contractor, made in writing within such 60-day period or authorized extension thereof, any and all such claims shall be conclusively deemed waived.

D. Subject to the provisions of Paragraph 15.03 C., the Contractor and Owner may agree upon the whole or any part of the amount or amounts to be paid to the Contractor by reason of the total or partial termination of work pursuant hereto, provided that such agreed amount or amounts shall never exceed the total contract price as reduced by the amount of payments otherwise made and as further reduced by the contract price of work not terminated. The contract shall be amended accordingly, and the Contractor shall be paid the agreed amount. No amount shall be due for lost or anticipated profits. Nothing in Paragraph 15.03 E., hereunder, prescribing the amount to be paid to the Contractor in the event of failure of the Contractor and the Owner to agree upon the whole amount to be paid to the Contractor by reason of the termination of work pursuant to this section, shall be deemed to limit, restrict or otherwise determine or affect the amount or amounts which may be agreed upon to be paid to the Contractor pursuant to this paragraph.

E. In the event of the failure of the Contractor and the Owner to agree, as provided in Paragraph 15.03 D., upon the whole amount to be paid to the Contractor by reason of the termination of work pursuant to this section, the Owner shall determine, on the basis of information available to it, the amount, if any, due to the Contractor by reason of the termination and shall pay to the Contractor the amounts determined. No amount shall be due for lost or anticipated profits.

F. In arriving at the amount due the Contractor under this section, there shall be deducted:

1. all unliquidated advance or other payments on account theretofore made to the Contractor, applicable to the terminated portion of this contract;
2. any claim which the Owner may have against the Contractor in connection with this contract; and
3. the agreed price for or the proceeds of sale of any materials, supplies or other things kept by the Contractor or sold, pursuant to the provisions of this clause, and not otherwise recovered by or credited to the Owner.

G. If the termination hereunder be partial prior to the settlement of the terminated portion of this contract, the Contractor may file with the Engineer a request in writing for an equitable adjustment of the price or prices specified in the contract relating to the continued portion of the contract (the portion not terminated by the notice of termination), and such equitable adjustment as may be agreed upon shall be made in such price or prices; nothing contained herein, however, shall limit the right of the Owner and the Contractor to agree upon the amount or amounts to be paid to the Contractor for the completion of the continued portion of the contract when said contract does not contain an established contract price for such continued portion.

H. Nothing contained in this section shall limit or alter the rights which the Owner may have for termination of this contract under Paragraph 15.02 hereof entitled "Contractor Default; Owner's Right to Suspend Work and Annual Contract" or any other right which Owner may have for default or breach of contract by Contractor.

SC-15.04

Delete Paragraph 15.04 of the General Conditions in its entirety.

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ARTICLE 16 - DISPUTE RESOLUTION

SC-16.01A

Delete the paragraph 16.01A of the General Conditions in its entirety and replace with the following:

Either Owner of Contractor may request mediation of any Claim submitted to Engineer for a decision under Paragraph 10.05 when such decision becomes final and binding. The mediation will be governed by the Construction Industry Mediation Rules of the American Arbitration Association in effect as of the Effective Date of this Agreement. The request for mediation shall be submitted in writing to the American Arbitration Association and the other party to the Contract.

SC-16.01C.3.

Add a new sentence at the end of paragraph 16.01C.3 of the General Conditions which is to read as follows:

D. Contractor shall carry on the Work and maintain the progress schedule during the dispute resolution proceedings, unless otherwise agreed by Contractor and Owner in writing.

ARTICLE 17 - MISCELLANEOUS

SC-17.01A.2.

Amend Paragraph 17.01A.2, by insert the words "return receipt requested" after the words "certified mail" .

SC-17.02A.

Amend Paragraph 17.02 A, by remove "such day will be omitted from the computation" in line 6 and replace it with "then the last day of such period shall be the next working day."

SC-17.05

Add a new paragraph after Paragraph 17.05 A. in the General Conditions which reads as follows:

B. Exclusive venue for any action under this Contract shall be a court of competent jurisdiction in Pope County, Arkansas.

SC-17.06

Add the following new paragraphs immediately after paragraph 17.06 of the General Conditions:

17.07 Addresses

A. Both the address given in the Bid Form upon which this Agreement is founded, and Contractor's office at or near the site of the Work are hereby designated as places to either of which notices, letters, and other communications to Contractor shall be certified, mailed, or delivered. The delivering at the above named place, or depositing in a postpaid wrapper directed to the first-named place, in any post office box regularly maintained by the post office department, of any notice, letter or other communication to Contractor shall be deemed sufficient service thereof upon Contractor; and the date of said service shall be the date of such

delivery or mailing. The first-named address may be changed at any time by an instrument in writing, executed and acknowledged by Contractor, and delivered to Owner and Engineer. Nothing herein contained shall be deemed to preclude or render inoperative the service of any notice, letter, or other communication upon Contractor personally.

17.08 Wage Rates

A. The requirements and provisions of all applicable laws and any amendments thereof or additions thereto as to the employment of labor, and to the schedule of minimum wage rates established in compliance with laws shall be a part of these Contract Documents. Copies of the wage schedules are included in PART II of these Supplementary Conditions. If, after the Notice of Award, it becomes necessary to employ any person in a trade or occupation not classified in the wage determinations, such person shall be paid at not less than such rates as shall be determined by the officials administrating the laws mentioned above. Such approved minimum rate shall be retroactive to the time of the initial employment of such person in such trade or occupation. Contractor shall notify Owner of Contractor's intention to employ persons in trades or occupations not classified in sufficient time for Owner to obtain approved rates for such trades or occupations.

B. The schedules of wages referred to above are minimum rates only, and Owner will not consider any claims for additional compensation made by Contractor because of payment by Contractor of any wage rate in excess of the applicable rate contained in these Contract Documents. All disputes in regard to the payment of wages in excess of these specified in the schedules shall be resolved by Contractor.

C. The said schedules of wages shall continue to be the minimum rates to be paid during the life of this Agreement and a legible copy of said schedules shall be kept posted in a conspicuous place at the site of the Work.

17.08 *No Waiver of Legal Rights*

A. Inspection by the Engineer; any order, measurement, quantity or certificate by the Engineer; any order by the Owner for payment of money; any payment for or acceptance of any work; or any extension of time or any possession taken by the Owner shall not operate as a waiver of any provisions of the contract or any power therein reserved to the Owner of any rights or damages therein provided. Any waiver of any breach of contract shall not be held to be a waiver of any other or subsequent breach. The Owner reserves the right to correct any error that may be discovered in any estimate that may have been paid and to adjust the same to meet the requirements of the contract documents. The Owner reserves the right to recover by process of law sums as may be sufficient to correct any error or make good any deficiency in the work resulting from such error, dishonesty or collusion by the Contractor or his agents and the Engineer or his assistants, discovered in the work after the final payment has been made. Neither final acceptance of the work nor final payment shall relieve the Contractor of responsibility for faulty materials or workmanship, and the Contractor shall promptly remedy any defects due thereto and pay for any damage to other work resulting therefrom. Likewise, neither final acceptance nor final payment, nor partial or entire use or occupancy of the work by the Owner shall constitute acceptance of work not done in accordance with the contract documents or relieve Contractor of liability with respect to any expressed or implied warranties or responsibility for faulty materials or workmanship, whether same be patently or latently defective.

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17.09 *Equal Employment Opportunity*

A. During the performance of this contract the Contractor agrees as follows:

1. Contractor shall not discriminate against any employee or applicant for employment because of race, color, religion, sex, age or national origin. The Contractor shall take affirmative action to insure that applicants are employed and that employees are treated during employment without regard to their race, color, sex, religion, age or national origin. Such action shall include, but not be limited to, the following: employment, upgrading, demotion or transfer; recruitment or recruitment advertising; layoff or termination, rates of pay or other forms of compensation; and selection for training, including apprenticeship. The Contractor agrees to post in conspicuous places, available to employees or applicants for employment, notices to be provided setting forth the provisions of this nondiscrimination clause.
2. Contractor shall, in all solicitations or, advertisements for employees placed by or on behalf of the Contractor, state that all qualified applicants shall receive consideration for employment without regard to race, color, religion, sex, national origin or age.
3. Contractor shall send to each labor union or representative of workers with which he has a collective bargaining agreement or other contract or understanding a notice to be provided, advising the said labor union or workers' representatives of the Contractor's commitments under this section, and shall post copies of the notice in conspicuous places available to employees and applicants for employment.
4. Contractor shall include the provisions of this section in all subcontracts pertaining to the work.
5. During the course of the work, the Contractor shall submit to the Engineer, on a monthly basis, a breakdown by minority group of all employees at the site of the work.

17.10 *Loss of Anticipated Profits*

A. Contractor will not be entitled to loss of anticipated profits pursuant to any claim under this Agreement.

17.11 *Obligation to Perform Functions*

A. Any failure or neglect on the part of Owner, Engineer or inspectors to enforce provisions herein dealing with supervision, control, inspection, testing or acceptance and approval of the work shall never operate to relieve Contractor from full compliance with the contract documents nor render Owner liable to CONTRACTOR for money damages, extensions of time or increased compensation of any kind.

PART II - STATE GOVERNMENT PROVISIONS

State Government Provisions included herein, have been selected from those to which specific references have been made elsewhere in the Contract Documents. Each and every other provision of law or clause required by law to be inserted in this Contract shall be deemed to be also inserted herein in accordance with paragraph 3.01D of the Supplementary Conditions.

1.0 STATE OF ARKANSAS PROVISIONS

1.1 Prevailing Wage Rates (Attached as Section 00801)

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SECTION 00801

PREVAILING WAGE RATE

MIKE BEEBE
GOVERNOR

STATE OF ARKANSAS
ARKANSAS DEPARTMENT OF LABOR
PREVAILING WAGE DIVISION

JAMES SALKELD
DIRECTOR

10421 WEST MARKHAM • LITTLE ROCK, AR 72205-2190
Phone: 501-682-4536 Fax: 501-682-4508 TRS: 800-285-1131

August 13, 2012

Matt Crow
CDM Smith
1401 W Capitol Ste 230
Little Rock, AR 72201

Re: POLLUTION CONTROL WORKS SCHEDULE I
DECHLORINATION SYSTEM
RUSSELLVILLE, ARKANSAS
POPE COUNTY

Dear Mr. Crow:

In response to your request, enclosed is Arkansas Prevailing Wage Determination Number **12-085** establishing the minimum wage rates to be paid on the above-referenced project. These rates were established pursuant to the Arkansas Prevailing Wage Law, Ark. Code Ann. §§ 22-9-301 to 22-9-315 and the administrative regulations promulgated thereunder.

If the work is subject to the Arkansas Prevailing Wage Law, every specification shall include minimum prevailing wage rates for each craft or type of worker as determined by the Arkansas Department of Labor Ark. Code Ann. § 22-9-308 (b) (2). Also, the public body awarding the contract shall cause to be inserted in the contract a stipulation to the effect that not less than the prevailing hourly rate of wages shall be paid to all workers performing work under the contract. Ark. Code Ann. § 22-9-308 (c).

Additionally, the scale of wages shall be posted by the contractor in a prominent and easily accessible place at the work site. Ark. Code Ann. § 22-9-309 (a).

Also enclosed is a **"Statement of Intent to Pay Prevailing Wages"** form that should be put in your specifications along with the wage determination. The General/Prime Contractor is responsible for getting this form filled out and returned to this office within 30 days of the Notice to Proceed for this project.

***When you issue the Notice to Proceed for this project, please send a copy of the notice to my office.***

If you have any questions, please call me at (501) 682-4536 or fax (501) 682-4508.

Sincerely,

Lorna Kay Smith

Lorna K. Smith
Prevailing Wage Division

Enclosures

**Arkansas Department of Labor**
**Prevailing Wage Determination**
**BUILDING RATES**

**Determination #:** 12-085
**Expiration Date:** 2/13/2013
**Survey#:** 712-AR10R

**Date:** 8/13/2012
**Project:** Pollution Control Works Schedule I - Dechlorination System
**Site:**
**City:** Russellville, Arkansas
**Project County:** Pope

| CLASSIFICATION | Basic Hourly Rate | Fringe Benefits |
|---|---|---|
| Asbestos Worker/Insulator | $11.90 | |
| Boilermaker | $19.10 | $6.21 |
| Bricklayer/Pointer, Cleaner, Caulker, Stone Mason | $19.85 | |
| Carpenter | $20.50 | $7.95 |
| Concrete Finisher/Cement Mason | $15.40 | $1.43 |
| Electrician/Alarm Installer | $18.40 | $1.50 |
| Glazier | $11.90 | |
| HVACR Mechanic (Excludes Duct Work) | $13.60 | $1.55 |
| Ironworker (Including Reinforcing Work) | $18.25 | $12.71 |
| Laborer | $11.90 | |
| Metal Building Erector | $15.70 | |
| Millwright | $22.50 | $6.40 |
| Painter/Sheet Rock Finisher | $12.75 | $0.45 |
| Plasterer | $14.00 | |
| Roofer | $15.45 | |
| Sheet Metal (Includes Duct Work) | $15.50 | $1.30 |
| Sprinkler Fitter | $22.10 | $8.45 |
| Truck Driver | $14.10 | $0.45 |
| Group 1 - Operator | $15.20 | $3.25 |
| Group 2 - Operator | $16.30 | |
| Group 3 - Operator | $16.50 | $1.65 |
| *Plumber/Pipefitter-Conway,Perry,Pope(except ATU) & Yell- Low | $22.50 | |
| *Plumber/Pipefitter-Franklin,Johnson,Logan&Pope(ATU only)- Hi | $22.50 | |
| *Plumber/Pipefitter-Conway,Perry,Pope(except ATU) & Yell- Hig | $22.50 | |
| *Plumber/Pipefitter-Franklin,Johnson,Logan&Pope(ATU only)- Lo | $22.50 | |

Welders-receive rate prescribed for craft performing operation to which welding is incidental.

**Certified 8/1/2012**

***Classifications that are required, but not listed above, must be requested in writing from the Arkansas Department of Labor, Prevailing Wage Division. Please call (501) 682-4536 for a request form.***

**Power Equipment Operators:**

**Group I**

Operators engaged in operating the following equipment: Cranes, draglines, shovels and piledrivers with a lifting capacity of 50 tons or over, and operators of all tower climbing cranes and derricks required to work 25 feet or over from the ground, blacksmith and mechanics.

**Group II**

Operators engaged in operating the following equipment or performing work relative to the engineer's jurisdiction: Hydraulic cranes, cherry pickers, backhoes, and all derricks with a lifting capacity less than 50 tons, as specified by the manufacturer, all backhoes, tractor or truck type, all overhead & traveling cranes, or tractors with swinging boom attachments, gradealls all above equipment irrespective of motive power, leverman (engineer), hydraulic or bucket dredges, irrespective of size, trackhoes, excavators.

**Group III**

Heavy Equipment Operators. Operators engaged in operating the following equipment: all bulldozers, all front end loaders, all sidebooms, skytracks, forklifts, all push tractors, all pull scrapers, all motor graders, all trenching machines, regardless of size or motive power, all backfillers, all central mixing plants, 10S and larger, finishing machines, all boiler fireman high or low pressure, all asphalt spreaders, hydro truck crane, multiple drum hoist, irrespective of motive power, all rotary, cable tool, core drill or churn drill, water well and foundation drilling machines, regardless of size, regardless of motive power and dredge tender operator, asphalt paving machines.

## STATEMENT OF INTENT TO PAY PREVAILING WAGES

PROJECT: **POLLUTION CONTROL WORKS SCHEDULE I - DECHLORINATION SYSTEM**
**RUSSELLVILLE, ARKANSAS**
**POPE COUNTY**

This is to certify that we, the following listed contractors, are aware of the wage requirements of the Arkansas Prevailing Wage Law and by signature below indicate our intent to pay no less than the rates established by **Arkansas Prevailing Wage Determination Number 12-085** for work performed on the above noted public project. I understand that contractors who violate prevailing wage laws, i.e., incorrect classification/scope of work of workers, improper payments of prevailing wages, etc., are subject to fines and will be required to pay back wages due to workers.

| | Business Name | Address | Phone# | Signature and Title of Business Official |
|---|---|---|---|---|
| General/Prime Contractor | | | | |
| Electrical Subcontractor | | | | |
| Mechanical Subcontractor | | | | |
| Plumbing Subcontractor | | | | |
| Roofing/ Sheet Metal Subcontractor | | | | |

THE GENERAL/PRIME CONTRACTOR IS RESPONSIBLE FOR GETTING THIS FORM FILLED OUT AND RETURNING IT TO THE ARKANSAS DEPARTMENT OF LABOR ***WITHIN 30 DAYS OF THE NOTICE TO PROCEED*** FOR THIS PROJECT. RETURN COMPLETED FORM TO THE ARKANSAS DEPARTMENT OF LABOR, PREVAILING WAGE DIVISION, 10421 W. MARKHAM, LITTLE ROCK, ARKANSAS, 72205.

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SECTION 00840

NOTICE OF AWARD

Dated _____, 2013

TO: _____(Bidder)

ADDRESS: _____

_____

_____

OWNER'S PROJECT NO.: 212130

PROJECT: Pollution Control Works Schedule II – Nitrate Removal. You are notified that your Bid dated _____, 2013, for the above Contract has been accepted. You are the apparent successful Bidder and have been awarded a contract for

_____

_____

The Contract Price of your Contract is

_____Dollars ($_____).

Five (5) copies of each of the proposed Contract Documents (except Drawings) accompany this Notice of Award. Five (5) 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 (10) days of the date of this Notice of Award, that is by

_____, 2013.

1. You must deliver to the Owner five (5) fully-executed counterparts of the Agreement.

2. You must deliver with the executed Agreement five (5) full-executed copies of the Performance and Payment Bonds. One (1) copy will be returned to you for filing with the Pope County Circuit Court. A copy of the bond must be returned to the Owner with the Circuit Court filing marks.

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3. Date all copies of the Agreement and the Performance and Payment Bonds for _____ (date of Owner's approval of Award).

Failure to comply with these conditions within the time specified will entitle Owner to consider your Bid abandoned, to annul this Notice of Award and to declare your Bid Security forfeited.

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

City Corporation
(Owner)

BY: _____
(Authorized Signature)

_____
(Title)

END OF SECTION

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SECTION 00845

NOTICE TO PROCEED

Dated _____, 2013

TO: _____(Bidder)

ADDRESS: _____

_____

_____

OWNER'S PROJECT NO.: 212130

PROJECT: Pollution Control Works Schedule II – Nitrate Removal

OWNER'S CONTRACT NO.:_____

You are notified that the Contract Time under the above Contract will commence to run on _____, 2013. By that date, you are to start performing your obligations under the Contract Documents. In accordance with Article 3 of the Agreement, the dates of Substantial Completion and Final Completion are _____, 2013 and _____, 2014 respectively.

Before you start any Work at the site, Paragraph 2.7 of the General Conditions provides that you must deliver to the Owner Certificates of Insurance which you are required to purchase and maintain in accordance with the Contract Documents.

ACKNOWLEDGED RECEIPT

| | |
|---|---|
| _____ | _____ |
| (Contractor) | (Owner) |
| BY:_____ | _____ |
| (Authorized Signature) | (Authorized Signature) |
| _____ | _____ |
| (Title) | (Title) |

END OF SECTION

# *DIVISION 1*

# *GENERAL REQUIREMENTS*

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SECTION 01010

SUMMARY OF WORK

PART 1: GENERAL

1.01 LOCATION OF WORK

A. The work of this Contract is located at the Pollution Control Works Treatment Plant, 404 Jimmy Lile RD, Russellville, Arkansas as indicated in the Plans.

1.02 SCOPE OF WORK

A. Furnish all labor, materials, equipment and incidentals required and construct the Pollution Control Work Plant Improvements Project, in its entirety as shown on the Drawings and specified herein.

B. The Work includes, but is not necessarily limited to, the following:

1. Distribution Structures.
2. Aeration Basins.
3. Secondary Clarifiers.
4. RAS/WAS Pump Stations.
5. Electrical building.
6. Demolition and site work.

1.03 WORK SEQUENCE

A. Perform Work according to the conditions of Section 01014 to ensure completion of the Work in the Contract Time. Completion dates of the various stages shall be in accordance with the approved construction schedule submitted by the Contractor. Work not specifically described in the Section 01014 may be scheduled at the Contractor's discretion and with the approval of the Engineer.

1.04 PROGRESS OF THE WORK

A. The work shall be started within 10 days following the Notice to Proceed, and the work shall be executed with such progress as may be required to prevent any delay to the general completion of the project. The work shall be executed at such times and in or on such parts of the project, and with such personnel, materials, and equipment to assure completion of the work in the time established by the Agreement.

B. If the Contractor for his convenience and at his own expense, should desire to conduct his work at night or outside regular hours, he shall submit written notice to the Owner and he shall allow ample time for satisfactory arrangements to be made for inspecting the work in

progress. The Contractor shall pay all expenses (at Engineer's standard rates) associated with extra inspection required for work outside regular hours. Regular working hours are defined as 10 hours per day, Monday through Friday, 7:00 a.m. to 6:00 p.m. The Contractor shall light the different parts of the project as required to comply with all applicable Federal and State regulations and with all applicable requirements of the City of Russellville.

1.05 CONSTRUCTION SCHEDULE

A. The Contractor shall, within fifteen (15) days after the effective date of the Agreement, provide and submit to the Engineer for approval, the Schedule for the first 60 days of activities. Within 45 days after the effective date of the Agreement the Contractor shall provide and submit to the Engineer the schedule he plans to maintain in order to successfully construct the work within the time allotted. The completed schedule shall be reviewed before additional monthly payments are made. The Schedule shall account for all the work of the Contractor and his Subcontractors and suppliers. In addition to all reasonably important construction activities, the Schedule shall provide for the proper sequence of construction considering the various crafts, purchasing time, submittal approval, material delivery, equipment fabrication, and similar time consuming factors.

B. The Schedule shall include, as a minimum, the earliest starting and finish dates, and latest starting and finish dates, and the total float for each task or item. The Contractor shall update (monitor) the schedule as necessary and shall submit to the Engineer a copy of the updated schedule with each monthly pay estimate. The schedule shall contain all of the items of the Periodic Estimate and Pay Schedule.

   While the Contractor bears full responsibility for scheduling all phases and stages of the work to ensure its successful prosecution and completion within the time specified in accordance with all provisions of these Specifications, the Contractor is specifically required to complete fully or complete such stages of work to enable his Subcontractors and suppliers to complete their work within the respective times specified.

C. If the Engineer determines that operations are falling behind schedule at any time during the construction period, the Owner may require the Contractor to add to his plan, equipment and/or construction forces, including increases in working hours, in such quantities as are required to bring operations back on schedule. Upon receipt of written communication from the Owner requiring such addition, the Contractor shall furnish same at no additional cost (including extra inspection and related engineering costs) to the Owner.

1.06 PRECONSTRUCTION CONFERENCE

A. A preconstruction conference shall be held as soon as possible after Award of Contract and before work is started. The conference will be held at a location selected by the Owner. The conference will be attended by:

   1. Contractor's Office Representative.

   2. Contractor's General Superintendent.

   3. Process Control System Integrator.

4. Any subcontractors' or suppliers' representatives whom the Contractor may desire to invite or the Engineer may request.

5. Engineer's Representatives.

6. Owner's Representatives.

7. Such other individuals that the Engineer may invite.

B. A suggested format would include, but not be limited to, the following subjects:

1. Check of required bonds and insurance certifications.

2. Liquidated damages.

3. Shop drawing submittal and approval procedure.

4. Chain of command, direction of correspondence, and coordinating responsibility between Contractors.

5. Request for periodic job meetings for all involved.

6. Introduction of the key project personnel.

7. Laboratory testing of material requirements.

8. Inventory of material stored on site provisions.

9. Progress estimate and payment procedure.

C. The Engineer will preside at the conference, prepare the minutes of the meeting and distribute copies of same to all participants who so request by fully completing the attendance form to be circulated at the beginning of the conference.

1.07 COORDINATION WITH OWNER'S OPERATIONS AND EXISTING FACILITIES

A. Several parts of the proposed work under this Contract will connect with or into existing facilities. Many of such contact locations are particularly sensitive because of the attendant necessary down time of existing wastewater treatment operations, because of the possibility of contamination of potable water, or because of the extraordinary inconvenience to the Owner's personnel and to the routine which is required in the continuous operation. Because of this sensitivity, the Contractor shall plan carefully the schedule of that portion of the work that will affect the existing facilities. Such plans and schedules shall be subject to the approval of the Owner and Engineer.

B. Work that requires shutdown or in any way impedes the operations of existing facilities shall be closely coordinated with the City Corporation staff in accordance with Section 01014.

C. The Contractor shall outline and submit a scheduled plan with the construction schedule for installation of the work that requires interruption of operations.

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1.08 CONTRACTOR'S USE OF PREMISES

A. Contractor shall limit the use of the premises for his/her Work and for storage to allow for:

1. Work by other contractors.

2. Owner occupancy.

3. Public use.

B. Coordinate use of premises with Owner.

C. Contractor shall assume full responsibility for security of all his/her and his/her subcontractor's materials and equipment stored on the site.

D. If directed by the Owner, move any stored items that interfere with operations of Owner or other contractors.

E. Obtain and pay for use of additional storage or work areas if needed to perform the Work.

F. Contractor shall submit to the Owner for approval a plan of operations, designating proposed areas of the property to be used for his operations, material storage, equipment storage, employee's parking, offices and shops. The area shall have minimal interference with the present operations.

G. Any damage to existing facilities, including contamination, which may be caused by Contractor's personnel, callers, visitors, materials or equipment, shall be repaired or corrected at the sole expense of the Contractor.

H. Any fence that is damaged or removed by the Contractor shall be replaced at the Contractor's expense in like and kind, and to the satisfaction of the Engineer.

1.09 OWNER OCCUPANCY

A. Owner will occupy premises during performance of the work for the conduct of his/her normal operations. Coordinate all construction operations with Owner to minimize conflict and to facilitate Owner usage.

PART 2 - PRODUCTS - NOT USED

PART 3 - EXECUTION - NOT USED

END OF SECTION

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SECTION 01025

MEASUREMENT AND PAYMENT

PART 1: GENERAL

1.01 SCOPE OF WORK

A. The scope of this section defines the items included in each bid item for the Schedule of Prices. Payment will be made based on the specified items included in the description in this section for each bid item.

B. All contract prices included in the bid form will be full compensation for all labor, materials, tools, equipment, and incidentals necessary to complete the construction as shown on the Drawings and/or as described in the Specifications to be performed under this contract. Actual quantities of each item bid on a unit price basis will be determined upon completion of the construction. Payment for all items in the bid form will constitute full compensation for all work to be performed under this Contract. No separate payment will be made for any item that is not specifically set forth in the Schedule of Prices, and all costs therefore shall be included in the prices named in the Schedule of Prices for the various appurtenant items of work.

1.02 POLLUTION CONTROL WORKS SCHEDULE II – NITRATE REMOVAL (ITEM A)

A. Measurement

1. Measurement of work for payment of this item shall be based upon lump sum bid for (bid item A) installed and accepted. The limits are as shown on the Drawings.

B. Payment

1. Payment of the lump sum in the Bid Form for furnishing, installing, constructing, and providing start-up services for the Pollution Control Works Schedule II – Nitrate Removal as shown on the drawings which shall be full compensation for all items necessary for a complete and working system including but, not limited to; clearing and grubbing, excavating, backfilling, erosion control, seeding, compacting, fencing, yard piping, valves, connective piping for all conveyance systems, demolition, structures, buildings, equipment, instrumentation, electrical, painting, roadway construction, and for all labor, materials, and incidentals for a complete and working system including start-up and warranty services.

1.03 EXCAVATION TRENCH SAFETY PROTECTIVE SYSTEM (ITEM B)

A. Measurement

1. Measurement of work for payment of this item shall lump sum for the trench safety protective system (bid item B) furnished and installed. The limits are as shown on the Drawings.

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B. Payment

1. Payment for this item shall be made in accordance with the lump sum price bid. The price bid shall be full compensation for the trench or excavation safety system requirements in accordance with ACT 291 of the 1993 Arkansas General Assembly. Payment under this item may not be made until the project is completed, accepted, and the contractor certifies that he has met all the requirements as set forth in said ACT 291.

1.03 ALLOWANCE FOR QUALITY CONTROL TESTING (ITEM C)

A. Measurement

1. Measurement of work for payment of this item shall be based upon the actual cost of performing the Quality Control Testing as specified in Section 01450.

B. Payment

1. Partial or full payment of the allowance in the Bid Form for providing Quality Control Testing shall be full compensation for all testing required to complete the scope of work.

2. Any remaining unused balance of this allowance item shall be credited to the Owner.

3. If this allowance is not adequate to compensate for all of the required testing, the Owner will issue a Change Order for the overage.

PART 2: PRODUCTS (NOT USED)

PART 3: EXECUTION (NOT USED)

END OF SECTION

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SECTION 01026

APPLICATION FOR PAYMENT

PART 1: GENERAL

1.01 REQUIREMENTS INCLUDED

A. Submit Applications for Payment to the Engineer in accordance with the schedule established by Conditions of the Contract and Agreement between Owner and Contractor.

B. The accepted Schedule of Values, Section 01026, shall be used as the basis for the Contractor's Application for Payment.

1.02 RELATED WORK

A. Agreement between Owner and Contractor is included in Section 00500.

B. Standard General Conditions of the Construction Contract are included in Section 00700.

C. Schedule of Values are included in Section 01026.

D. Construction Photographs are included in Section 01380.

E. Contract Closeout is included in Section 01700.

1.03 SUBMITTALS

A. Submit, in accordance with Section 01300, applications typed on forms provided by the Owner, Application for Payment, with itemized data typed on 8-1/2-in by 11-in or 8-1/2-in by 14-in white paper continuation sheets.

B. Provide itemized data on continuation sheet.

1. Format, schedules, line items and values: Those of the Schedule of Values accepted by the Engineer.

C. Provide construction photographs in accordance with Section 01380.

1.04 PREPARATION OF APPLICATION FOR EACH PROGRESS PAYMENT

A. Application Form

1. Fill in required information, including that for Change Orders executed prior to date of submittal of application.

2. Fill in summary of dollar values to agree with respective totals indicated on continuation sheets.

3. Execute certification with signature of a responsible officer of Contract firm.

B. Continuation Sheets

1. Fill in total list of all scheduled component items of Work, with item number and scheduled dollar value for each item.

2. Fill in dollar value in each column for each scheduled line item when work has been performed or products stored.

   a. Round off values to nearest dollar, or as specified for Schedule of Values.

3. List each Change Order executed prior to date of submission, at the end of the continuation sheets.

   a. List by Change Order Number and description, as for an original component item of work.

4. To receive approval for payment on component material stored on site, submit copies of the original paid invoices with the application for payment.

1.05 SUBSTANTIATING DATA FOR PROGRESS PAYMENTS

A. When the Owner or the Engineer requires substantiating data, submit suitable information, with a cover letter identifying.

1. Project.

2. Application number and date.

3. Detailed list of enclosures.

4. For stored products:

   a. Item number and identification as shown on application.

   b. Description of specific material.

B. Submit one copy of data and cover letter for each copy of application.

C. As a prerequisite for payment, submit a "Surety Acknowledgement of Payment Request" letter showing amount of progress payment which the Contractor is requesting.

D. Maintain an updated set of drawings to be used as record drawings in accordance with Section 01720. As a prerequisite for monthly progress payments, exhibit the updated record drawings for review by the Owner and the Engineer.

1.06 PREPARATION OF APPLICATION FOR FINAL PAYMENT

A. Fill in Application form as specified for progress payments.

B. Use continuation sheet for presenting the final statement of accounting as specified in Section 01700 - Contract Closeout.

C. Submit all Project Record Documents in accordance with Section 01720.

1.07 SUBMITTAL PROCEDURE

A. Submit Applications for Payment to the Engineer at the times stipulated in the Agreement.

B. Number: Five copies of each Application.

C. When the Engineer finds Application properly completed and correct, he/she will transmit certificate for payment to Owner, with copy to Contractor.

PART 2: PRODUCTS (NOT USED)

PART 3: EXECUTION (NOT USED)

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SECTION 01035

CHANGE ORDER PROCEDURES

PART 1: GENERAL

1.01 REQUIREMENTS INCLUDED

A. Promptly implement change order procedures.

1. Provide full written data required to evaluate changes.

2. Maintain detailed records of work done on a time-and-material/ force account basis.

3. Provide full documentation to Engineer on request.

B. Designate in writing the member of Contractor's organization:

1. Who is authorized to accept changes in the work.

2. Who is responsible for informing others in the Contractor's employ of the authorization of changes in the work.

C. Owner will designate in writing the person who is authorized to execute Change Orders.

1.02 RELATED REQUIREMENTS

A. Agreement, the amounts of established unit prices, is included in Section 00300.

B. Conditions of the Contract are included in Section 00700.

1. Methods of determining cost or credit to Owner resulting from changes in work made on a time and material basis.

2. Contractor's claims for additional costs.

C. Applications for Payment are included in Section 01052.

D. Schedule of Values is included in Section 01370.

F. Project Record Documents are included in Section 01781.

1.03 DEFINITIONS

A. Change Order: See Contract for Construction.

B. Construction Change Authorization: A written order to the Contractor, signed by Owner and Engineer, which amends the Contract Documents as described and authorized Contractor to proceed with a change which affects the Contract Sum or the Contract Time, for inclusion in a subsequent Change Order.

C. Architect's Supplemental Instructions, AIA Document G710: A written order, instructions, or interpretations, signed by Architect/Engineer making minor changes in the Work not involving a change in Contract Sum or Contract Time.

D. Field Order: A written order to the Contractor signed by the Engineer and the Contractor, which is issued to interpret/clarify the Contract Documents, order minor changes in the work and/or memorialize trade-off agreements. The work described by a Field Order is to be accomplished without change to the Contract Sum, Contract Time, and/or claims for other costs.

1.04 PRELIMINARY PROCEDURES

A. Owner or Engineer may initiate changes by submitting a Request for Proposal (RFP) to Contractor. Request will include:

1. Detailed description of the Change, Products and location of the change in the project.

2. Supplementary or revised Drawings and Specifications.

3. The projected time span for making the change and a specific statement as to whether overtime work is, or is not, authorized.

4. A specific period of time during which the requested price will be considered valid.

5. Such request is for information only and is not an instruction to execute the changes, nor to stop work in progress.

B. Contractor may initiate changes by submitting a written notice to Engineer, containing:

1. Description of the proposed changes.

2. Statement of the reason for making the changes.

3. Statement of the effect on the Contract Sum and the Contract Time.

4. Statement of the effect on the work of separate contractors.

5. Documentation supporting any change in Contract Sum or Contract Time, as appropriate.

1.05 WORK DIRECTIVE CHANGE AUTHORIZATION

A. In lieu of a Request for Proposal (RFP), Engineer may issue a work directive authorization for Contractor to proceed with a change for subsequent inclusion in a Change Order.

B. Authorization will describe changes in the work, both additions and deletions, with attachments of revised Contract Documents to define details of the change and will designate the method of determining any change in the Contract Sum and any change in Contract Time.

C. Owner and Engineer will sign and date the Work Directive Change Authorization as authorization for the Contractor to proceed with the changes.

D. Contractor will sign and date the Construction Change Authorization to indicate agreement with the terms therein.

1.06 DOCUMENTATION OF PROPOSALS AND CLAIMS

A. Support each quotation for a lump-sum proposal and for each unit price which has not previously been established, with sufficient substantiating data to allow Engineer to evaluate the quotation.

B. On request, provide additional data to support time and cost computations including:

1. Labor required.

2. Equipment required.

3. Products required.

a. Recommended source of purchase and unit cost.

b. Quantities required.

4. Taxes, insurance and bonds.

5. Credit for work deleted from Contract, similarly documented.

6. Overhead and profit.

7. Justification for any change in Contract Time.

C. Support each claim for additional costs and for work done on a time-and-material/force account basis, with documentation as required for a lump-sum proposal, plus additional information.

1. Name of the Owner's authorized agent who ordered the work and date of the order.

2. Dates and times work was performed and by whom.

3. Time record, summary of hours worked and hourly rates paid.

4. Receipts and invoices for:

a. Equipment used, listing dates and times of use.

b. Products used, listing of quantities.

c. Subcontracts.

1.07 PREPARATION OF CHANGE ORDERS AND FIELD ORDERS

A. Engineer will prepare each Change Order and Field Order.

B. Change Order will describe changes in the work, both additions and deletions, with attachments of revised Contract Documents to define details of the change.

C. Change Order will provide an accounting of the adjustment in the Contract Sum and in the Contract Time.

D. Field Order will describe interpretations or clarifications of Contract Documents, order minor changes in the work, and/or memorialize trade-off agreements.

E. Field Order work will be accomplished without change in the Contract Sum, Contract Time, and/or claims for other costs.

1.08 LUMP-SUM/FIXED PRICE CHANGE ORDER

A. Content of Change Orders will be based on, either:

1. Engineer's Proposal Request and Contractor's responsive Proposal as mutually agreed between Owner and Contractor.

2. Contractor's Proposal for a change, as recommended by Engineer.

B. Owner and Engineer will sign and date the Change Order as authorization for the Contractor to proceed with the changes.

C. Contractor will sign and date the Change Order to indicate agreement with the terms therein.

1.09 UNIT PRICE CHANGE ORDER

A. Content of Change Orders will be based on, either:

1. Engineer's definition of the scope of the required changes.

2. Contractor's Proposal for a change, as recommended by Engineer.

3. Survey of completed work.

B. The amounts of the unit prices to be:
1. Those stated in the Agreement.

2. Those mutually agreed upon between Owner and Contractor.

C. When quantities of each of the items affected by the Change Order can be determined prior to start of the work:

1. Owner and Engineer will sign and date the Change Order as authorization for Contractor to proceed with the changes.

2. Contractor will sign and date the Change Order to indicate agreement with the terms therein.

D. When quantities of the items cannot be determined prior to start of the work:

1. Engineer or Owner will issue a construction change authorization directing Contractor to proceed with the change on the basis of unit prices, and will cite the applicable unit prices.

2. At completion of the change, Engineer will determine the cost of such work based on the unit prices and quantities used.

   a. Contractor shall submit documentation to establish the number of units of each item and any claims for a change in Contract Time.

3. Engineer will sign and date the Change Order to establish the change in Contract Sum and in Contract Time.

4. Owner and Contractor will sign and date the Change Order to indicate their agreement with the terms therein.

1.10 TIME AND MATERIAL/FORCE ACCOUNT CHANGE ORDER/WORK DIRECTIVE CHANGE AUTHORIZATION

A. Engineer and Owner will issue a Work Directive Change Authorization directing Contractor to proceed with the changes.

B. At completion of the change, submit itemized accounting and supporting data as provided in the Article "Documentation of Proposals and Claims" of this Section.

C. Engineer will determine the allowable cost of such work, as provided in General Conditions and Supplementary Conditions.

D. Engineer will sign and date the Change Order to establish the change in Contract Sum and in Contract Time.

E. Owner and Contractor will sign and date the Change Order to indicate their agreement therewith.

1.11 CORRELATION WITH CONTRACTOR'S SUBMITTALS

A. Periodically revise Schedule of Values and Request for Payment forms to record each change as a separate item of work, and to record the adjusted Contract Sum.

B. Periodically revise the Construction Schedule to reflect each change in Contract Time.

   1. Revise subschedules to show changes for other items of work affected by the changes.

C. Upon completion of work under a Change Order, enter pertinent changes in Record Documents.

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PART 2: PRODUCTS (NOT USED)

PART 3: EXECUTION (NOT USED)

END OF SECTION

**CHANGE ORDER No. 1**
**City Corporation**
**Pollution Control Works Plant Schedule II – Nitrate Removal**
**City Corporation Project No. 212130**
**CDM Smith PROJECT No. 89452**

Date of Issuance:_____ Effective Date: _____

OWNER City Corporation

OWNER's Contract No.: 212130 CDM Project No.: 89452

CONTRACTOR: _____ ENGINEER: CDM Smith

You are directed to make the following changes in the Contract Documents:

Description: **See Attachment "A"**

Reason for change order: **See Attachment "A"**

Change order cost: **See Attachment "B"**

Attachments: (List documents supporting change) see **Attachment "C"**

| CHANGE IN CONTRACT PRICE | CHANGE IN CONTRACT TIME |
|---|---|
| Original Contract Price | Original Contract Times<br>Substantial Completion:<br>Final Completion: |
| Net changes from previous Change Orders<br>($0) | Net change from previous Change Orders |
| Contract Price prior to this Change Order | Contract Time prior to this Change Order<br>Substantial Completion :<br>Final Completion: |
| Net Increase (decrease) in this Change Order | Net Increase (Decrease) in this Change Order |
| Contract Price with all approved Change Orders | Contract Time with approved Change Order No. 1<br>Substantial Completion:<br>Final Completion: |

RECOMMENDED BY APPROVED BY: ACCEPTED BY:

_____ _____ _____
Engineer (Authorized Signature) Owner (Authorized Signature) Contractor (Authorized Signature)

Date:_____ Date:_____ Date:_____

# CHANGE ORDER No. 1
# ATTACHMENT A

**City Corporation**
**Pollution Control Works Plant Schedule II – Nitrate Removal**
**City Corporation Project No. 212130**
**CDM Smith PROJECT No. 89452**

## SCOPE OF CHANGE

| ITEM | DESCRIPTION |
|---|---|
| 1. | Description: |
| | Reason: |
| | Cost: |

# CHANGE ORDER No. 1
# ATTACHMENT B

**City Corporation**
**Pollution Control Works Plant Schedule II – Nitrate Removal**
**City Corporation Project No. 212130**
**CDM Smith PROJECT No. 89452**

## ITEMIZED COST

| Item No. | Description | Units | Quantity | Unit Cost | Total |
|---|---|---|---|---|---|
| 1 | | | | | |
| 2 | | | | | |
| | **Total** | | | | **$** |

# CHANGE ORDER No. 1
# ATTACHMENT C

**City Corporation**
**Pollution Control Works Plant Schedule II – Nitrate Removal**
**City Corporation Project No. 212130**
**CDM Smith PROJECT No. 89452**

## SUPPORTING DOCUMENTATION

| ITEM | DESCRIPTION |
|---|---|
| 1 | |

# Field Order

*To:* _____ *Field Order No.:* _____

_____ *Date:* _____

_____ *Project No.:* _____

*Attention:*

*Subject:*

This Field Order is issued to interpret/clarify the Contract Documents, or order minor changes in the work. The work described by this Field Order is to be accomplished without change in Contract Price, Contract Time, and/or claims with other costs.

DESCRIPTION:

ATTACHMENTS:

REFERENCES:

CDM

By: _____

Date: _____

CONTRACTOR: _____

By: _____

Date: _____

cc:

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SECTION 01045

CUTTING AND PATCHING

PART 1: GENERAL

1.01 SCOPE OF WORK

A. This Section covers the cutting, coring, rough and finished patching of holes and openings. Holes and opening may be in existing construction, or in parts of new construction. Procedures for cutting and patching will be the same for either condition.

B. All cutting, coring, and rough patching shall be performed by the Contractor or Prime Contractor requiring the opening. Finish patching shall be the responsibility of the Contractor or Prime Contractor requiring the opening and shall be performed by the trade associated with the application of the particular finish.

C. Provide all cutting, fitting and patching, including attendant excavation and backfill, required to complete the work or to:

1. Make its several parts fit together properly.

2. Uncover portions of the work to provide for installation of ill timed or improperly scheduled work.

3. Remove and replace defective work.

4. Remove and replace work not conforming to requirements of Contract Documents.

5. Remove samples of installed work as specified for testing.

6. Provide penetrations of structural surfaces and materials for installation of piping, ductwork, equipment and electrical conduit.

7. Provide penetrations of non-structural surfaces and materials for installation of piping, ductwork, equipment and electrical conduit. The determination of what is a nonstructural surface or material shall be made by the Engineer.

8. Remove, install, or relocate materials or equipment.

1.02 RELATED WORK

A. Section 01010 – Summary of Work.

B. Division 2 - Site work.

C. Concrete is included in Division 3.

D. Pipe penetrations and assemblies are included in Section 01180.

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1.03 SUBMITTALS

A. Submit, in accordance with Section 01300, a written request prior to executing any cutting or alteration which is not shown or detailed on the contract documents which affects or requires:

1. Cutting structural members.
2. Holes drilled in beams or other structural members.
3. Work of the Owner or any separate contractor.
4. Structural value or integrity of any element of the project.
5. Integrity or effectiveness of weather-exposed or moisture-resistant elements or systems.
6. Efficiency, operational life, maintenance or safety of operational elements.
7. Visual qualities of sight-exposed elements.

B. Request shall include:

1. Identification of the project.
2. Description of affected work.
3. The reason for cutting, alteration or excavation.
4. Effect on work of Owner or any separate contractor, or on structural or weatherproof integrity of project.
5. Description of proposed work:
   a. Method and extent of cutting, patching, alteration, or excavation.
   b. Trades who will execute the work.
   c. Products proposed to be used.
   d. Extent of refinishing to be done.
6. Alternatives to cutting and patching.
7. If the work is considered out of scope, provide a cost proposal.
8. Confirmation of coordination with any separate contractor whose work will be affected.
9. Related shutdown requests if required to do the work.
10. Request for hot work permit if required to do the work.

C. Submit written notice to the Engineer designating the date and the time the work will be uncovered.

D. When a written request is required, do not proceed with the work until a written notice to proceed is received from the Engineer.

PART 2: PRODUCTS

2.01 MATERIALS

A. Comply with specifications and standards for each specific product involved. Where there is no equivalent specification, the Contractor shall notify the Engineer who will provide a specification for the materials to be used.

B. Concrete and grout for rough patching shall be as specified in Divisions 3 and 4.

C. Materials for finish patching shall be equal to those of adjacent construction. Where existing materials are no longer available, use materials with equivalent properties and that will provide the same appearance. The materials are to be approved by the Engineer prior to their use.

PART 3: EXECUTION

3.01 INSPECTION

A. Inspect existing conditions of project, including elements subject to damage or to movement during cutting and patching.

B. After uncovering work, inspect conditions affecting installation of products, or performance of work.

C. Report unsatisfactory or questionable conditions to the Engineer in writing; do not proceed with work until the Engineer has provided further instructions.

3.02 PREPARATION

A. Provide adequate temporary support as necessary to assure structural value or integrity of affected portion of work.

B. Protect surrounding materials and equipment prior to starting work.

C. Contain and control cooling liquids and slurry produced by the cutting and coring operations.

D. When the cutting or coring will result in the structure or equipment being exposed to provide adequate weather protection.

E. Provide dewatering for excavation work in accordance with Section 02140.

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3.03 PERFORMANCE

A. Execute cutting and demolition by methods which will prevent damage to other work and will provide proper surfaces to receive installation of repairs.

B. Execute excavating and backfilling by methods which will prevent settlement or damage to other work. When excavating in close proximity to piping, duct banks or other items subject to damage, use hand excavation.

C. All equipment and workplace safety shall conform to OSHA standards and specifications pertaining to plugs, noise and fume pollution, wiring and maintenance.

D. Where possible, employ original installer or fabricator to perform cutting and patching for:

1. Weather-exposed or moisture-resistant elements.

2. Sight-exposed finished surfaces.

E. Execute fitting and adjustment of products to provide a finished installation to comply with specified products, functions, tolerances and finishes.

F. Restore work which has been cut or removed; install new products to provide completed work in accordance with requirements of Contract Documents.

G. Refinish entire surfaces as necessary to provide an even finish to match adjacent finishes:

1. For continuous surfaces, refinish to nearest intersection.

2. For an assembly, refinish entire unit.

H. Remove rubble and excess patching materials from the premises.

3.04 CORING

A. All coring shall be performed in such a manner as to limit the extent of patching. Locate the rebar before coring to minimize cut throughs.

B. Coring shall be performed with an approved non-impact rotary tool with diamond core drills.

C. Size of holes shall be suitable for pipe, conduit, sleeves, equipment or mechanical seals to be installed.

D. Fit work to minimize space to pipes, sleeves, ducts, conduit and other penetrations through surfaces.

E. Fit to pipes and other penetrations in tanks to be water tight using seals or other methods defined in the specifications.

F. All holes cut through concrete and masonry walls, slabs or arches shall be core drilled unless otherwise approved. All work shall be performed by mechanics skilled in this type of work.

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H. If holes are cored through floor slabs they shall be drilled from below where possible. If holes are drilled from above, provide protection and containment below the area being drilled to catch the plug and contain liquid and slurry.

3.05 CUTTING

A. All cutting shall be performed in such a manner as to limit the extent of patching.

B. Fit work to minimize space to pipes, sleeves, ducts, conduit and other penetrations through surfaces.

C. Cutting shall be performed with a concrete saw and diamond saw blades of proper size.

D. Provide for control of slurry generated by sawing operation on both sides of wall and from below if cutting a floor.

E. When cutting a reinforced concrete wall or floor, the cutting shall be done so as not to damage the bond between the concrete and reinforcing steel left in structure. Cut shall be made so that steel neither protrudes nor is recessed from face of the cut.

F. Adequate bracing of area to be cut shall be installed prior to start of cutting. Check area during sawing operations for partial cracking and provide additional bracing as required to prevent a partial release of cut area during sawing operations.

G. Provide equipment of adequate size to remove cut panel.

H. Saw cut concrete and masonry prior to breaking out sections.

I. Install work at such time as to require the minimum amount of cutting and patching.

J. All cutting of structural members shall be done in a manner directed by the Engineer.

K. Cut opening only large enough to allow easy installation of the equipment, ducting, piping or conduit.

L. When existing conduits or pipe sleeves are cut off at the floor line or wall line, they shall be filled with grout or suitable patching material.

3.06 PROTECTION

A. Provide devices and methods to protect other portions of project from damage.

B. Provide protection from elements for that portion of the project which may be exposed by cutting and patching work.

C. Maintain excavations free from water.

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3.07 PATCHING

A. Rough patching shall be such as to bring the cut or cored area flush with existing construction unless otherwise shown.

B. Finish patching shall match existing surfaces as approved.

C. Patching shall be of the same kind and quality of material as was removed.

D. The completed patching work shall restore the surface to its original appearance or better.

E. Patching of waterproofed surfaces shall render the area of the patching completely waterproofed to include the joint between the existing material and the patch.

F. Equipment damaged during cutting and patching shall be replaced or repaired by the equipment manufacturer, at the Engineer's sole discretion and at the expense of the Contractor doing the work.

G. Repaint any damage to factory applied paint finishes using touch-up paint furnished by the equipment manufacturer. The entire damaged panel or section shall be repainted in accordance with the field painting requirements specified in Section 09903 at the expense of the Contractor doing the work.

H. Slurry or tailings resulting from coring or cutting operations shall be contained and vacuumed or otherwise removed from the area following drilling or cut.

I. Equipment shall be protected against mechanical and water damage during cutting and patching. Provide protective covers or use other means such as temporary relocation to protect equipment that is at risk of damage from the cutting and patching

J. Provide protection for existing equipment, utilities and critical areas against water or other damage caused by drilling operation.

END OF SECTION

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SECTION 01046

CONTROL OF WORK

PART 1 GENERAL

1.01 SUMMARY

A. Contractor is responsible for the control of all work, including all "means and methods" of completing the Work.

1.02 RELATED SECTIONS

A. Section 01665 – Trenching Safety Requirements.

B. Section 02270 – Erosion and Sedimentation Control.

1.03 CONTRACTOR'S PLANT

A. Furnish Contractor's plant and equipment that will be efficient, appropriate and large enough to secure a satisfactory quality of work; and a rate of progress that will ensure the completion of the Work within the Contract Time. If at any time such plant appears to be inefficient, inappropriate or insufficient for securing the quality of work required or for producing the rate of progress aforesaid, Engineer may order the Contractor to increase the efficiency, change the character, or increase the plant equipment; and the Contractor shall conform to such order. Failure of the Engineer to give such order shall in no way relieve the Contractor of his obligations to secure the quality of the work and rate of progress required.

1.04 PRIVATE LAND

A. Do not enter or occupy private land outside of easements, except by permission of the land owner.

1.05 PIPE LOCATIONS

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

1.06 OPEN EXCAVATIONS

A. Adequately safeguard all open excavations by providing temporary barricades, caution signs, lights and other means to prevent accidents to persons and damage to property. Provide suitable and safe bridges and other crossings for accommodating travel by pedestrians and workmen. Remove bridges provided for access during construction when no longer required. The length or size of excavation will be controlled by the particular surrounding conditions, but shall always be confined to the limits prescribed by the Engineer. If the excavation

becomes a hazard, or if it excessively restricts traffic at any point, the Engineer may require special construction procedures such as limiting the length of the open trench, prohibiting stacking excavated material in the street and requiring that the trench shall not remain open overnight.

B. Take precautions to prevent injury to the public due to open trenches. Provide adequate light at all trenches, excavated material, equipment, or other obstacles which could be dangerous to the public at night.

1.07 TEST PITS

A. Excavate test pits, at the direction of the Engineer, to locate underground pipelines or structures in advance of the construction. Backfill test pits immediately after their purpose has been satisfied and restore and maintain the surface in a manner satisfactory to the Engineer.

1.08 MAINTENANCE OF TRAFFIC

A. Unless permission to close a street is received in writing from the proper authority, place all excavated material so that vehicular and pedestrian traffic may be maintained at all times. If the construction operations cause traffic hazards, repair the road surface, provide temporary ways, erect wheel guards or fences, or take other measures for safety satisfactory to the Engineer.

B. Detours around construction will be subject to the approval of the Owner and the Engineer. Where detours are permitted, provide all necessary barricades and signs as required to divert the flow of traffic. Expedite construction operations while traffic is detoured. Periods when traffic is being detoured will be strictly controlled by the Owner.

C. Take precautions to prevent injury to the public due to open trenches. Night watchmen may be required where special hazards exist, or police protection provided for traffic while work is in progress. Be fully responsible for damage or injuries whether or not police protection has been provided.

D. Use of police for traffic control shall be in conformance with City of Russellville standards.

1.09 CARE AND PROTECTION OF PROPERTY

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

1.10 PROTECTION AND RELOCATION OF EXISTING STRUCTURES AND UTILITIES

A. Assume full responsibility for the protection of all buildings, structures, and utilities, public or private, including poles, signs, services to buildings, utilities in the street, gas pipes, water pipes, hydrants, sewers, drains and electric and telephone cables, whether or not they are

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shown on the Drawings. Carefully support and protect all such structures and utilities from injury of any kind. Immediately repair any damage resulting from the construction operations.

B. Assistance will be given the Contractor in determining the location of existing services. The Contractor, however, shall bear full responsibility for obtaining all locations of underground structures and utilities (including existing water services, drain lines and sewers). Maintain services to buildings and pay costs or charges resulting from damage thereto.

C. Notify Arkansas One-Call (800-482-8998) at least 48 hours (excluding Saturdays, Sundays and Legal holidays) before commencing any excavation.

D. Coordinate the removal and replacement of traffic loops and signals, if required for the performance of the work, at no additional cost to the Owner.

1.11 WATER FOR CONSTRUCTION PURPOSES

A. In locations where public water supply is available, the Contractor may be allowed to use water without charge for construction purposes.

B. The express approval of the Owner shall be obtained before water is used. Waste of water shall be sufficient cause for withdrawing the privilege of unrestricted use. Hydrants shall only be operated under the supervision of the Owner's personnel.

1.12 MAINTENANCE OF FLOW

A. Provide for the flow of sewers, drains and water courses interrupted during the progress of the work, and immediately cart away and remove all offensive matter. Discuss the entire procedure of maintaining existing flow with the Engineer one week in advance of the interruption of any flow.

1.13 COOPERATION WITHIN THIS CONTRACT

A. All firms or persons authorized to perform any work under this Contract shall cooperate with Prime Contractor and Subcontractors or trades and assist in incorporating the work of other trades where necessary or required.

B. Cutting and patching, drilling and fitting shall be carried out where required by the trade or subcontractor having jurisdiction, unless otherwise indicated herein or directed by the Engineer.

1.14 CLEANUP AND DISPOSAL OF EXCESS MATERIAL

A. During the course of the work, keep the site of operations as clean and neat as possible. Dispose of all residue resulting from the construction work and, at the conclusion of the work, remove and haul away any surplus excavation, broken pavement, lumber, equipment, temporary structures and any other refuse remaining from the construction operations and leave the entire site of the work in a neat and orderly condition.

B. In order to prevent environmental pollution arising from the construction activities related to the performance of this Contract, comply with all applicable Federal, State and local laws and

regulations concerning waste material disposal, as well as the specific requirements stated in this Section and in other related Sections.

C. Disposal of excess excavated material in wetlands, stream corridors and plains is strictly prohibited even if the permission of the property owner is obtained. Any violation of this restriction by the Contractor or any person employed by him will be brought to the immediate attention of the responsible regulatory agencies, with a request that appropriate action be taken against the offending parties. The Contractor will be required to remove the fill and restore the area impacted at no increase in the Contract Price.

PART 2: PRODUCTS (NOT USED)

PART 3: EXECUTION (NOT USED)

END OF SECTION

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SECTION 01171

ELECTRIC MOTORS (Up to 250 HP)

PART 1: GENERAL

1.01 SCOPE OF WORK

A. Motors up to 250 horsepower (hp) furnished under other Sections shall be in conformance with the requirements listed in this Section, unless otherwise noted.

B. Motors connected to variable frequency drive controllers shall be inverter duty rated.

1.02 RELATED WORK

A. Variable Frequency Drive Controllers are specified in Section 16482.

1.03 SUBMITTALS

A. Submittal of motor data for acceptance shall be in accordance with Section 01300 and shall include complete nameplate data and test characteristics in accordance with the latest version of NEMA Standard MG1-12. In addition, the following data for the motors shall be provided:

1. Efficiency at 1/2, 3/4, and full load.
2. Power factor at 1/2, 3/4, and full load.
3. Motor outline drawings, dimensions, and weight.
4. Descriptive bulletins, including full description of insulation system.
5. Bearing design data and L-10 bearing life.
6. Special features (i.e., space heaters, temperature detectors, etc.).
7. Power factor correction capacitor rating and type.
8. Insulation information.
9. Locked Rotor Amperes at rated voltage and NEMA starting code letter.
10. Temperature rise.
11. Service factor.

B. Operations and maintenance data is specified under 1.09.

1.04 REFERENCE STANDARDS

A. Institute of Electrical and Electronics Engineers (IEEE)

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B. National Electrical Manufacturers Association (NEMA)

C. National Electrical Code (NEC)

D. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.05 QUALITY ASSURANCE

A. Routine tests shall be performed on representative motors, and shall include the information described on NEMA MG1-12. Efficiency shall be determined in accordance with IEEE Publication No. 112, Method B. Power factor shall be measured on representative motors.

1.06 SYSTEM DESCRIPTION

A. Motors specified herein are three-phase, squirrel-cage induction type for 1/2-hp and above; single-phase for less than 1/2-hp; or DC motors.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Delivery, storage, and handling of motors shall be in accordance with Section 01600.

1.08 PROJECT/SITE REQUIREMENTS

A. Ambient temperature at job site range from 20 to 110 degrees Fahrenheit.

1.09 MAINTENANCE

A. Provide operation and maintenance data in accordance with Sections 16000 and 01730.

1.10 WARRANTY

A. All equipment supplied under this Section shall be warranted by the Contractor and the equipment manufacturers for a period of two years from startup, in accordance with Section 01740.

PART 2: PRODUCTS

2.01 RATING

A. Each motor shall develop ample torque for its required service throughout its acceleration range at a voltage 10 percent below nameplate rating.

B. The motor shall not be required to deliver more than its rated nameplate horsepower, at unity (1.0) service factor, under any condition of mechanical or hydraulic loading.

C. All motors shall be continuous time rated, suitable for operation in a 50 degrees C ambient temperature, unless noted otherwise.

D. All motors shall be continuous time rated, suitable for operation at 1,000-ft above mean sea level.

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E. Specific motor data, such as horsepower, speed (rpm), enclosure type, etc., is specified under the detailed specification for the equipment with which the motor is supplied.

F. Motors connected to Variable Frequency Drive Controllers shall be inverter duty rated and conform to detailed standards outlined in NEMA MG1, Part 31, latest edition.

## 2.02 ENCLOSURE TYPES

A. Motors specified herein will conform to one of the following standard enclosure designs:

1. Open Drip Proof
2. Totally Enclosed Fan Cooled (TEFC)
3. Totally Enclosed Non-Ventilated (TENV)
4. Inverter Duty
5. Explosion-proof
6. Severe Duty

## 2.03 NAMEPLATES

A. The motor manufacturer's nameplates shall be embossed on stainless steel and fastened to the motor frame with stainless steel screws or drive pins. Nameplates shall indicate clearly all of the items of information enumerated in NEMA Standard MG1-10.39 or MG1-20.25, as applicable.

## 2.04 CONDENSATION HEATERS

A. Condensation heaters, where specified under the detailed mechanical specifications, shall be of the cartridge or flexible wrap-around type installed within the motor enclosure adjacent to core iron. Heaters shall be rated for 120-V, single-phase with wattage as required to maintain internal temperature rise of 5 to 10 degrees Centigrade above ambient during periods of shut-down. The heater wattage and voltage shall be embossed on the motor nameplate. Power leads for heaters shall be brought out at the motor lead junction box.

## 2.05 WINDING TEMPERATURE DETECTORS

A. All motors shall be provided with winding temperature detectors. Winding temperature detectors shall be a factory-installed, embedded, bi-metallic switch type, one per phase, with leads terminating in the main conduit box. This device shall protect the motor against damage from overheating caused by single-phasing, overload, high ambient temperature, abnormal voltage, locked rotor, frequent starts, or ventilation failure. The switch shall have normally closed contacts. Not less than three detectors shall be furnished with each motor.

B. Motors connected to variable frequency drives shall be equipped with winding temperature detectors, in accordance with 2.05.A.

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2.06 SINGLE-PHASE MOTORS

A. Unless otherwise specified, motors smaller than 1/2 hp shall be single-phase, capacitor start. Small fan motors may be split-phase or shaded pole type if such are standard for the equipment. Wound rotor or commutator type single-phase motors are not acceptable, unless their specific characteristics are necessary for the application.

B. Motors shall be rated for operation at 115-V, single-phase, 60-Hz.

C. Locked rotor current shall not be greater than specified in NEMA Standard MG1-12.33, Design "N".

D. Motors shall be totally-enclosed in conformance with NEMA Standard MG1. Small fan motors may be open type if suitably protected from moisture, dripping water, and lint accumulation.

E. Motors shall be provided with sealed ball bearings lubricated for 10 years' normal use.

2.07 THREE-PHASE MOTORS - FRAMES 143T THROUGH 449T

A. General

1. Unless otherwise specified, motors 1/2 hp and larger shall be three-phase, squirrel-cage induction type.

2. All motors 3/4 hp and larger shall be a NEMA frame 143T or larger. 1/2-hp motors and 3/4-hp motors rated 1800 and 3600 rpm shall be a 56 frame. Motors shall be designed and connected for operation on a 480-V, three-phase, 60-Hz alternating current system. Dual voltage (230/460) rated motors are acceptable.

3. Unless otherwise required by the load, all motors shall be NEMA Design B, normal starting torque. Locked rotor kVA/hp shall not exceed Code Letter G as described in NEMA Standard MG1-10.37 for motors 20 hp and larger.

4. Motors connected to variable frequency drives shall be inverter duty rated.

5. Motors shall be by U.S. Electrical Motors, Division of Emerson Electric Co.; or equal.

B. Bearings

1. Anti-friction motor bearings shall be designed to be regreasable and initially shall be filled with grease suitable to ambient temperature of 50 degrees C. Bearings shall be ABMA Types BT, TS, or RN, heavy-duty, or shall otherwise be shown to be suitable for the intended application in terms of L-10 rating life or better.

2. All greased lubricated bearings, except those specified to be factory-sealed and lubricated, shall be fitted with easily accessible grease supply, flush, drain, and relief fittings. Extension tubes shall be used when necessary. Grease supply fittings shall be standard hydraulic type by the Alemite Division of the Stewart-Warner Corporation.

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C. Insulation

1. Insulation systems shall be Class F, operated at Class B temperature rise as measured by resistance based on a 50 degrees Centigrade ambient temperature, and shall be manufacturer's premium grade, resistant to attack by moisture, acids, alkalis, and mechanical or thermal shock for 480V motors.

2. Motors shall have vacuum/pressure impregnated epoxy insulation for moisture resistance.

3. Insulation for inverter duty motor windings shall meet or exceed the Pulse Endurance Index for magnetic wire and shall not be injured when exposed to repeated pulse type waveforms, repetitive high-voltage transients, switching frequency, and rate of rise of the pulse. Class H varnish shall be used.

D. Enclosures

1. Motors shall have a steel or cast iron frame and a cast iron or stamped steel conduit box, as specified below. Conduit box shall be split from top to bottom and shall be capable of being rotated to four positions. Synthetic rubber-like gaskets shall be provided between the frame and the conduit box and between the conduit box and its cover. Motor leads shall be sealed with a non-wicking, non-hygroscopic insulating material. A frame-mounted pad with drilled and tapped hole, not less than 1/4-in diameter, shall be provided inside the conduit box for motor frame grounding.

   a. Totally enclosed fan cooled: TEFC motors shall have a steel or cast iron frame, cast iron end brackets, cast iron conduit box, 1.15 service factor at 50 degrees C, tapped drain holes (corrosion-resistant plugs for frames 286T and smaller, and automatic breather/drain devices for frames 324T and larger), and upgraded insulation by additional dips and bakes to increase moisture resistance.

   b. Totally enclosed non-ventilated: TENV motors shall include the same rating and accessories as specified for TEFC motors.

   c. Explosion-proof: Explosion-proof motors shall have a cast iron frame, cast iron end brackets, cast iron conduit box, 1.15 service factor at 50 degrees C, tapped drain holes (corrosion-resistant plugs for frames 286T and smaller, and automatic breather/drain devices for frames 324T and larger), and be Underwriters Laboratories Inc. (UL) listed for Class 1, Div. 1, Group D hazardous areas.

   d. Severe duty: Motors shall be of the corrosion-resistant type conforming to motors designated by the manufacturer as "Corro-Duty", "Mill and Chemical", "Custom Severe Duty", or similar quality designation. Severe-duty motors shall have a cast iron frame, cast iron end brackets, cast iron conduit box and 1.15 service factor at 50 degrees C, and tapped drain holes (corrosion-resistant plug for frames 286T and smaller, and automatic breather/drain devices for frames 324T and larger).

E. Inverter Duty Rated Motors

1. Inverter duty rated: Motors for operation on variable frequency drives shall meet current power quality levels published in NEMA MG1, Part 31, latest edition. Consideration shall be given to the primary factors of the variable frequency drive, such as the modulation scheme (six-step, PWM, etc.), the switching or carrier frequency, and the type of power output devices utilized (IGBT, etc.). Consideration shall also be given to

the installation methods, such as output cable length, cable installation method, installation of output filters, etc. Motor shaft and bearings shall be insulated. Internal service factor shall be 1.0 that of the nameplate. Unless otherwise noted, provide enclosures suitable for "severe duty". Ventilation system shall be designed for maximum heat transfer. Stator laminations shall be stagger-stacked and stamped from high-grade electrical steel to minimize eddy-current losses and heat build-up caused by inverter induced harmonics. Rotors shall be configured to minimize skin-effect heating.

F. Motor Efficiencies

1. Three-phase motors rated one (1) horsepower and larger shall be premium efficiency and shall conform to the nomenclature identified as "NEMA PREMIUM". Motors shall carry the NEMA PREMIUM nameplate. Motors shall have a NEMA Nominal Efficiency not less than the values indicated by NEMA PREMIUM product. Efficiency values shall be based on tests performed in accordance with IEEE Publication No. 112, Method B. Motors with horsepower or speed not listed shall conform to comparable standards of construction and materials as those for listed motors.

G. Power Factor Correction Capacitors

1. All single-speed motors over five horsepower (except motors powered from variable frequency drives) shall be provided with a heavy-duty industrial type power factor correction capacitor selected, recommended, and furnished by the motor manufacturer to raise the motor power factor to approximately 90 percent. For non-explosion-proof motors, the capacitor shall be mounted on the equipment base plate adjacent to the motor and shall be connected to the motor junction box with liquid-tight flexible conduit. For explosion-proof motors, the capacitors shall be wall-mounted in a non-hazardous area.

2. Capacitors shall be dry film or liquid insulated and shall be hermetically sealed in steel enclosures.

3. Each capacitor unit shall be furnished with three high interrupting capacity current limiting fuses. Fuses shall be equipped with "blown-fuse" indicators.

4. Capacitor enclosures shall be suitable for conduit connection. Covers shall be gasketed, bolt-on type.

5. Capacitors shall be UL listed.

6. Capacitors shall be by General Electric Co., Square D Co., or equal.

2.08 SHOP TESTING

A. All motors shall be given a routine test per NEMA MG1 standard, and test results shall be submitted to Engineer.

PART 3: EXECUTION (NOT USED)

END OF SECTION

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SECTION 01180

PIPE PENETRATIONS

PART 1: GENERAL

1.01 SCOPE OF WORK

A. Furnish all labor, materials, equipment and incidentals required and install pipe penetration assemblies as shown. This Section covers materials for the various pipe penetration configurations as shown on the Drawings.

1.02 SUBMITTALS

A. Submit manufacturers' literature, installation instructions, and where applicable, fire rating and certified test results of the various components on all items to be furnished in accordance with Section 01300.

PART 2: PRODUCTS

2.01 PIPE SLEEVES

A. Pipe sleeves shall be Schedule 40 galvanized steel pipe conforming to ASTM A53 unless stainless steel mechanical seals are required in which case the sleeve material shall match the specified mechanical seal metal material. Provide a 2-in minimum circumferential water stop welded to exterior of sleeve at its midpoint. Ends of sleeves shall be cut and ground smooth and shall be flush with the wall or ceiling and extend 2-in above finished floors. Sleeves to be sealed with mechanical seals shall be sized in accordance with the seal manufacturer's recommendations. Sleeves to be sealed by caulking and sleeves for insulated piping shall be sized as required. In lieu of galvanized steel pipe the contractor can provide a molded non-conductive, high impact resistant HDPE as manufactured by PSI-Thunderline/Link-Seal of Houston Texas or approved equal, for pipe sizes up to 24 inches. Where mechanical seals are required, the seal material shall be compatible with the materials conveyed by the pipe.

B. External wall penetrations 36-in diameter and less may be made by means of a ductile iron sleeve capable of being bolted directly to the formwork. Seal of the annular space between the carrier pipe and the sleeve shall be made by means of a confined rubber gasket and be capable of withstanding 350 psi. Sleeve shall have an integrally cast waterstop of 1/2-in minimum thickness, 2-1/2-in minimum height. Sleeves shall be by Omni-Sleeve, Malden, MA or equal. In lieu of a ductile iron sleeve for openings greater than 36 inches the contractor can provide interlocking hole forming disks produces from non-conducive plastic as manufactured by PSI-Thunderline/Link-Seal of Houston Texas or equal

2.02 WALL CASTINGS

A. Unless otherwise shown, wall castings shall be ductile iron conforming to ANSI/AWWA A21.51/C151, thickness Class 53, diameter as required. Flanges and/or mechanical joint bells shall be drilled and tapped for studs where flush with the wall. Castings shall be provided with a 2-in minimum circumferential flange/waterstop integrally cast with or welded to the casting, located as follows: for castings set flush with walls located at the center of the overall

length of the casting; for castings which extend through wall located within the middle third of the wall.

2.03 SEALING MATERIALS

A. Mechanical seals shall be modular, adjustable, bolted, mechanical type consisting of interlocking synthetic rubber links shaped to continuously fill the annular space between the pipe and sleeve. The seal shall be rated by the manufacturer for 40-ft of head or 20 psig. Mechanical seals shall be Link-Seal LS-500 depending on pipe size, Model S-316 or OS-316 depending on application, by PSI Thunderline Corp., Houston, TX or equal.

B. Sealant shall be a two part foamed silicone elastomer by Dow Corning Co., Product No. 3-6548 silicone R.T.V.; 3M brand fire barrier products caulk C.P. 25 and 3M brand putty 303; or Flame-Safe fire stop systems Fig. No. FS-500 by Thomas & Betts Corp. Sealant bead configuration, depth and width shall be in accordance with manufacturer's recommendations.

2.04 MISCELLANEOUS MATERIALS

A. Bonding compound shall be Sikadur 32, Hi-Mod epoxy by Sika Corp.; Euclid Chemical Corp.; Master Builders Company or equal.

B. Non-shrink grout shall be Masterflow 713 by Master Builders Co.; Euco N-S by Euclid Chemical Co.; Five Star Grout by U.S. Grout Corp. or equal.

PART 3: EXECUTION

3.01 INSTALLATION

A. Assemble and install components of pipe penetration assemblies as recommended by product manufacturers and as detailed on the Drawings.

END OF SECTION

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SECTION 01200

PROJECT MEETINGS

PART 1: GENERAL

1.01 SCOPE OF WORK

A. Schedule, attend, and administer as specified, preconstruction conference, periodic progress meetings, and specially called meetings throughout progress of the Work.

B. Representatives of Contractor, subcontractors and suppliers attending meetings shall be qualified and authorized to act on behalf of the entity each represents.

C. Meetings administered by Owner may be tape recorded. If recorded, tapes will be used to prepare minutes and retained by Owner for future reference.

D. Meetings, in addition to those specified in this Section, may be held when requested by the Owner, Engineer or Contractor.

1.02 RELATED WORK

A. Pre-bid conference is included in Information to Bidders.

1.03 PRECONSTRUCTION CONFERENCE

A. A preconstruction conference will be scheduled after award of Contract and before Work is started. The conference will be scheduled and administered by the Construction Manager.

B. The Construction Manager will preside at the conference, prepare the minutes of the meeting and distribute copies of same to all participants who so request by fully completing the attendance form to be circulated at the beginning of the conference.

C. Attendance:

1. Contractor's project manager.

2. Contractor's superintendent.

3. Any subcontractor or supplier representatives whom the Contractor may desire to invite or the Owner may request.

4. Engineer's representatives.

5. Owner's representatives.

6. Others as appropriate.

D. Preliminary Agenda:

Introductions

1. Schedule completion dates and liquidated damages.
2. Construction Scheduling, including critical path.
3. Designation of responsible personnel.
4. Authority of Contractor.
5. Authority of Construction Manager and Engineer.
6. Submittals.
7. Procedures for Change Orders, Field Orders, RFIs, etc.
8. Record Drawings
9. Quality Control.
10. Safety Procedures.
11. Temporary construction facilities.
12. Temporary utilities facilities.
13. Security and work after normal hours.
14. Measurement and payment.
15. Project Work Summary
16. Correspondence Routing
17. Pay Request Procedures

1.04 PROGRESS MEETINGS

A. Formal project coordination meetings will be held periodically (not more than once weekly, nor less than once monthly). Meetings will be scheduled and administered by Construction Manager. Additional progress meetings to discuss specific topics will be conducted on an as-needed basis. Such additional meetings shall include, but not be limited to:

1. Coordinating plant/equipment shutdowns.
2. Installation of equipment.
3. Start-up of equipment or plant.

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4. Problem Area Resolutions

5. Equipment approval.

B. The Construction Manager will preside at progress meetings, prepare the minutes of the meeting and distribute copies of same to all participants who so request by fully completing the attendance form to be circulated at the beginning of each meeting.

C. Attendance: Same as preconstruction conference.

D. Preliminary Agenda:

1. Review, approval of minutes of previous meeting.

2. Review of work progress since previous meeting.

3. Field observations, problems, conflicts.

4. Problems which impede construction schedule.

5. Review of off-site fabrication, delivery schedules.

6. Review of construction interfacing and sequencing requirements with other construction contracts.

7. Corrective measures and procedures to regain projected schedule.

8. Revisions to construction schedule.

9. Progress, schedule, during succeeding work period.

10. Coordination of schedules.

11. Review submittal schedules.

12. Maintenance of quality standards.

13. Pending changes and substitutions.

14. Review proposed changes for:

    a. Effect on construction schedule and on completion date.

    b. Effect on other contracts of the Project.

15. Review Record Documents.

16. Review monthly pay request.

17. Review status of RFIs.

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PART 2: PRODUCTS (NOT USED)

PART 3: EXECUTION (NOT USED)

END OF SECTION

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# SECTION 01300

# SUBMITTALS

## PART 1: GENERAL

### 1.01 SCOPE OF WORK

A. This Section includes the requirements for compiling, processing and transmitting submittals required for execution of the project.

B. Submittals are categorized into two types: Action Submittals and Informational Submittals, as follows:

1. **Action Submittal:** Written and graphic information submitted by the Contractor that requires the Engineer's approval. The following are examples of action submittals:

   a. Shop drawings (including working drawings and product data)

   b. Samples

   c. Operation & maintenance manuals

   d. Site Usage Plan (Contractor's staging - including trailer sitting and material lay down area)

   e. Schedule of values

   f. Payment application format

2. **Informational Submittal:** Information submitted by the Contractor that does not require the Engineer's approval. The following are examples of informational submittals:

   a. Shop drawing schedule

   b. Construction schedule

   c. Statements of qualifications

   d. Health and Safety Plans

   e. Construction photography and videography

   f. Work plans

   g. Maintenance of traffic plans

   h. Outage requests

   i. Proposed testing procedures

j. Test records and reports

k. Vendor training outlines/plans

l. Test and start-up reports

m. Certifications

n. Record Drawings

o. Record Shop Drawings

p. Submittals required by laws, regulations and governing agencies

q. Submittals required by funding agencies

r. Other requirements found within the technical specifications

s. Warranties and bonds

t. As-built surveys

u. Contract close-out documents

1.02 RELATED WORK

A. Additional requirements may be specified in the General Conditions for the Contract.

B. Additional submittal requirements may be specified in the respective technical Specification Sections.

C. Operation and Maintenance manuals are included in Section 01730.

D. Contract closeout submittals are included in Section 01700.

E. Warranties and Bonds are included in Section 01740.

F. Construction Photos are included in Section 01380.

G. Construction Schedules are included in Section 01310.

H. Field Engineering is included in Section 01050.

I. Project Record Documents are included in Section 01720.

1.03 CONTRACTOR'S RESPONSIBILITIES

A. All submittals shall be clearly identified as follows:

1. Date of submission

2. Project number
3. Project name
4. Contractor identification
    a. Contractor
    b. Supplier
    c. Manufacturer
    d. Manufacturer or supplier representative
5. Identification of the product
6. Reference to Contract drawing(s)
7. Reference to specification section number, page and paragraph(s)
8. Reference to applicable standards, such as ASTM or Federal Standards numbers
9. Indication of Contractor's approval
10. Contractor's Certification statement
11. Identification of deviations from the Contract Documents, if any
12. Reference to previous submittal (for resubmittals)

B. Submittals shall be clear and legible, and of sufficient size for legibility and clarity of the presented data.

C. SUBMITTAL LOG

Maintain a log of all submittals. The submittal log shall be kept accurate and up to date. This log should include the following items (as applicable):

1. Description
2. Submittal number
3. Date transmitted to the Engineer
4. Date returned to Contractor (from Engineer)
5. Status of Submittal (Approved/Not Approved/etc.)
6. Date of Resubmittal to Engineer and Return from Engineer (if applicable and repeat as necessary)

7. Date material released for fabrication

8. Projected (or actual) delivery date

D. NUMBERING SYSTEM

Utilize a 9-character submittal identification numbering system in the following manner:

1. The first character shall be a D, S, M or I which represents Shop Drawing (including working drawings and product data), Sample, Manual (Operating & Maintenance) or Informational, respectively.

2. The next five digits shall be the applicable Section Number.

3. The next two digits shall be the numbers 01 to 99 to sequentially number each separate item or drawing submitted under each specific Specification Section, in the order submitted.

4. The last character shall be a letter, A to Z, indicating the submission (or resubmission) of the same submittal, i.e., "A" = 1st submission, "B" = 2nd submission, "C" = 3rd submission, etc. A typical submittal number would be as follows:

D-03300-008-B

D = Shop Drawing
03300 = Section for Concrete
08 = the eighth different submittal under this section
B = the second submission (first resubmission) of that particular shop drawing.

E. STATEMENT OF CONFORMANCE

1. Provide a Statement of Conformance letter at the front of each submittal stating conformance to the Drawings and Specifications with all exceptions clearly noted. Statement of conformance must be signed by an individual authorized to make such statements. Omission of the Statement of Conformance letter or failure to note all exceptions to or variances from the Drawings and Specifications in the Statement of Conformance is justification for submittal rejection.

F. ACTION SUBMITTALS

1. SHOP DRAWINGS, WORKING DRAWINGS, PRODUCT DATA AND SAMPLES

a. SHOP DRAWINGS

1) Shop drawings as defined in the General Conditions, and as specified in individual Sections include, but are not necessarily limited to, custom prepared data such as fabrication and erection/installation (working) drawings, scheduled information, setting diagrams, actual shop work manufacturing instructions, custom templates, wiring diagrams, coordination drawings, equipment inspection and test reports, including performance curves and certifications, as applicable to the work.

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2) Contactor shall verify all field measurements, field construction criteria, materials, dimensions, catalog numbers and similar data, and coordinate each item with other related shop drawings and the Contract requirements.

3) All details on shop drawings shall show clearly the relation of the various parts to the main members and lines of the structure and where correct fabrication of the work depends upon field measurements, such measurements shall be made and noted on the drawings before being submitted.

4) All shop drawings submitted by subcontractors and vendors shall be reviewed by the Contractor for field measurements, field construction criteria, materials, dimensions, catalog numbers and similar data, and that it has been coordinated with other related shop drawings and the Contract requirements. Submittals directly from subcontractors or vendors will not be accepted by the Engineer.

5) The Contractor shall be responsible the accuracy of the subcontractor's or vendor's submittal; and, for their submission in a timely manner to support the requirements of the Contractor's construction schedule. Shop drawings found to be inaccurate or otherwise in error shall be returned to the subcontractor or vendor to correct before submission to the Engineer. All shop drawings shall be approved by the Contractor.

6) Delays to construction due to the untimely submission of submittals will constitute inexcusable delays, for which Contactor shall not be eligible for additional cost nor additional contract time. Inexcusable delays consist of any delay within the Contactor's control.

7) Submittals for equipment specified under Divisions 11, 13, 14, 15 and 16 shall include a listing of installations where identical or similar equipment manufactured by that manufacturer has been installed and in operation for a period of at least five years.

b. WORKING DRAWINGS

1) Detailed installation drawings (sewers, equipment, piping, electrical conduits and controls, HVAC work, and plumbing, etc.) shall be prepared and submitted for review and approval by the Engineer prior to installing such work. Installation drawings shall be to-scale and shall be fully dimensioned.

2) Piping working drawings shall show the laying dimensions of all pipes, fittings, valves, as well as the equipment to which it is being connected. In addition, all pipe supports shall be shown.

3) Equipment working drawings shall show all equipment dimensions, anchor bolts, support pads, piping connections and electrical connections. In addition, show clearances required around such equipment for maintenance of the equipment.

4) Electrical working drawings shall show conduits, junction boxes, disconnects, control devices, lighting fixtures, support details, control panels, lighting and power panels, and Motor Control Centers. Coordinate all locations with the Contract Documents and the Contractor's other working drawings.

c. PRODUCT DATA

1) Product data, as specified in individual Specification Sections, include, but are not limited to, the manufacturer's standard prepared data for manufactured products (catalog data), such as the product specifications, installation instructions, availability of colors and patterns, rough-in diagrams and templates, product photographs (or diagrams), wiring diagrams, performance curves, quality control inspection and reports, certifications of compliance (as specified or otherwise required), mill reports, product operating and maintenance instructions, recommended spare parts and product warranties, as applicable.

d. SAMPLES

1) Furnish, samples required by the Contract Documents for the Engineer's approval. Samples shall be delivered to the Engineer as specified or directed. Unless specified otherwise, provide at least two samples of each required item. Materials or equipment for which samples are required shall not be used in the work unless and until approved by the Engineer.

2) Samples specified in individual Specification Sections, include, but are not limited to: physical examples of the work (such as sections of manufactured or fabricated work), small cuts or containers of materials, complete units of repetitively-used products, color/texture/pattern swatches and range sets, specimens for coordination of visual effect, graphic symbols, and other specified units of work.

3) Approval of a sample shall be only for the characteristics or use named in such approval and shall not be construed to change or modify and Contract Requirements.

4) Approved samples not destroyed in testing shall be sent to the Engineer or stored at the site of the work. Approved samples of the hardware in good condition will be marked for identification and may be used in the work. Materials and equipment incorporated in work shall match the approved samples. Samples which fail testing or are not approved will be returned to the Contractor at his expense, if so requested at time of submission.

e. PROFESSIONAL ENGINEER (P.E.) CERTIFICATION FORM

1) If specifically required in any of the technical Specification Sections, submit a Professional Engineer (P.E.) Certification for each item required, using the form appended to this Section, signed and sealed by the P.E. licensed or registered in the state wherein the work is located.

2. CONTRACTOR'S CERTIFICATION

a. Each shop drawing, working drawings, product data, and sample shall have affixed to it the following Certification Statement:

*"Certification Statement: by this submittal, I hereby represent that I have determined and verified all field measurements, field construction criteria,*

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*materials, dimensions, catalog numbers and similar data and I have checked and coordinated each item with other applicable approved shop drawings and all Contract requirements.*"

b. Shop drawings, working drawings, and product data sheets 11-in x 17-in and smaller shall be bound together in an orderly fashion and bear the above Certification Statement on the cover sheet. The transmittal cover sheet for each identified shop drawing shall fully describe the packaged data and include a listing of all items within the package.

3. The review and approval of shop drawings, working drawings, product data, or samples by the Engineer shall not relieve the Contractor from the responsibility for the fulfillment of the terms of the Contract. All risks of error and omission are assumed by the Contractor and the Engineer will have no responsibility therefor.

4. Project work, materials, fabrication, and installation shall conform to approved shop drawings (including working drawings and product data) and applicable samples.

5. No portion of the work requiring a shop drawing (including working drawings and product data) or sample shall be started, nor shall any materials be fabricated or installed before approval of such item. Procurement, fabrication, delivery or installation or products or materials that do not conform to approved shop drawings shall be at the Contractor's risk. Furthermore, such products or materials delivered or installed without approved shop drawings, or in non-conformance with the approved shop drawings will not be eligible for progress payment until such time as the product or material is approved or brought into compliance with approved shop drawings. Neither the Owner nor Engineer will be liable for any expense or delay due to corrections or remedies required to accomplish conformity.

6. OPERATION AND MAINTENANCE DATA

a. Operation and maintenance data shall be submitted in assembled manuals as specified. Such manuals shall include detailed instructions for Owner personnel on safe operation procedures, controls, start-up, shut-down, emergency procedures, storage, protection, lubrication, testing, trouble-shooting, adjustments, repair procedures, and other maintenance requirements.

7. SCHEDULE OF VALUES

a. On projects consisting of lump sums (in whole or in part) submit a proposed schedule of values providing a breakdown of lump sum items in to reasonably small components – generally disaggregated by building, area, and/or discipline. The purpose of the schedule of values is for processing partial payment applications. If requested by the Engineer, provide sufficient substantiation for all or some items as necessary to determine the proposed schedule of values is a reasonable representation of the true cost breakdown of the Work. The schedule of values shall not be unbalanced to achieve early payment or over-payment in excess of the value of work or any other mis-distribution of the costs. If, in the opinion of the Engineer, the schedule of values is unbalanced, Contractor shall reallocate components to achieve a balanced schedule acceptable to Engineer.

8. PAYMENT APPLICATION FORMAT

a. If an application form is included in the Contract Documents, use that form unless otherwise approved by the Engineer and Owner. If an application form is not included in the Contract Documents, Contractor may propose a form for approval.

9. SITE USAGE

a. Submit a proposed site staging plan, including but not limited to the location of office trailers, storage trailers and material lay down. Such plan shall be a graphic presentation (drawing) of the proposed locations; and, shall include on-site traffic modifications, and temporary utilities, as may be applicable.

G. INFORMATIONAL SUBMITTALS

1. SHOP DRAWING SCHEDULE

a. Prepare and submit a schedule indicating when shop drawings are required to be submitted to support the as-planned construction schedule. The submittal schedule shall allow sufficient time for preparation and submittal, review and approval, and fabrication and delivery to support the construction schedule.

2. CONSTRUCTION SCHEDULE

a. Prepare and submit construction schedules and monthly status reports as specified.

3. STATEMENTS OF QUALIFICATIONS

a. Provide evidence of qualification, certification, or registration, as required in the Contract Documents, to verify qualifications of licensed land surveyor, professional engineer, materials testing laboratory, specialty subcontractor, technical specialist, consultant, specialty installer, and other professionals.

4. HEALTH AND SAFETY PLANS

a. when specified, prepare and submit a general company Health and Safety Plan (HSP), modified or supplemented to include job-specific considerations.

5. CONSTRUCTION PHOTOGRAPHY AND VIDEOGRAPHY

a. Provide periodic construction photographs and videography as specified – including but not limited to preconstruction photographs and/or video, monthly progress photos and/or video and post-construction photographs and/or video.

6. WORK PLANS

a. Prepare and submit copies of all work plans needed to demonstrate to the Owner that Contractor has adequately thought-out the means and methods of construction and their interface with existing facilities.

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7. MAINTENANCE OF TRAFFIC PLANS

   a. Prepare maintenance of traffic plans where and when required by the Contract Documents and by local ordinances or regulations. If Contractor is not already knowledgeable about local ordinances and regulations regarding maintenance of traffic requirements, become familiar with such requirements and include all costs for preparation and submittal of traffic management plans and all associated costs for permits and fees to implement the traffic management plan, in the bid amount. In addition, unless a supplemental payment provision is provided in the bid form, include the cost of police attendance, when required.

8. OUTAGE REQUESTS

   a. Provide sufficient notification of any outages required (electrical, flow processes, etc) as may be required to tie-in new work into existing facilities. Unless specified otherwise elsewhere, a minimum of seven calendar days notice shall be provided.

9. PROPOSED TESTING PROCEDURES

   a. Prepare and submit testing procedures it proposes to use to perform testing required by the various technical specifications.

10. TEST RECORDS AND REPORTS

   a. Provide copies of all test records and reports as specified in the various technical specifications.

11. VENDOR TRAINING OUTLINES/PLANS

   a. At least two weeks before scheduled training of Owner's personnel, provide lesson plans for vendor training in accordance with the specification for O&M manuals.

12. TEST AND START-UP REPORTS

   a. Manufacture shall perform all pre-start-up installation inspection, calibrations, alignments, and performance testing as specified in the respective Specification Section. Provide copies of all such test and start-up reports.

13. CERTIFICATIONS

   a. Provide various certifications as required by the technical specifications. Such certifications shall be signed by an officer (of the firm) or other individual authorized to sign documents on behalf of that entity.

   b. Certifications may include, but are not limited to:

      1) Welding certifications and welders qualifications

      2) Certifications of Installation, Testing and Training for all equipment

      3) Material Testing reports furnished by an independent testing firm

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4) Certifications from manufacturer(s) for specified factory testing

5) Certifications required to indicate compliance with any sustainability or LEEDS accreditation requirements indicated in the Contract Documents

14. RECORD DRAWINGS

a. No later than Substantial Completion, submit a record of all changes during construction not already incorporated into drawings – in accordance with specification on Project Record Documents.

15. RECORD SHOP DRAWINGS

a. Before final payment is made, furnish one set of record shop drawings to the Engineer. These record shop drawings shall be in conformance with the approved documents and should show any field conditions which may affect their accuracy.

16. SUBMITTALS REQUIRED BY LAWS, REGULATIONS AND GOVERNING AGENCIES

a. Prepare and submit all documentation required by state or local law, regulation or government agency directly to the applicable agency. This includes, but is not limited to, notifications, reports, certifications, certified payroll (for projects subject to wage requirements) and other documentation required to satisfy all requirements. Provide to Engineer one copy of each submittal made in accordance with this paragraph.

17. SUBMITTALS REQUIRED BY FUNDING AGENCIES

a. Prepare and submit all documentation required by funding agencies. This includes, but is not limited to segregated pay applications and change orders when required to properly allocate funds to different funding sources; and certified payrolls for projects subject to wage requirements. Provide one copy of each submittal made in accordance with this paragraph to the Engineer.

18. OTHER REQUIREMENTS OF THE TECHNICAL SPECIFICATION SECTIONS

a. Comply with all other requirements of the technical specifications.

19. WARRANTIES AND BONDS

a. Assemble a book(let) of all warranties and bonds as specified in the various technical specifications and in accordance with the specification on Warranties and Bonds and provide to the Engineer.

20. AS-BUILT SURVEYS

a. Engage the services of a licensed land surveyor in accordance with the Project Controls specification. Prior to Final Completion, provide an as-built survey of the constructed facility, as specified.

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21. CONTRACT CLOSE-OUT DOCUMENTS

a. Submit Contract documentation as indicated in the specification for Contract Close-out.

PART 2: PRODUCTS (NOT USED)

PART 3: EXECUTION

3.01 SUBMITTAL SCHEDULE

A. Provide an initial submittal schedule at the pre-construction meeting for review by Owner and Engineer. Incorporate comments from Owner or Engineer into a revised submittal schedule.

B. Maintain the submittal schedule and provide sufficient copies for review by Owner and Engineer. An up-to-date submittal schedule shall be provided at each project progress meeting.

3.02 TRANSMITTALS

A. Prepare separate transmittal sheets for each submittal. Each transmittal sheet shall include at least the following: the Contractor's name and address, Owner's name, project name, project number, submittal number, description of submittal and number of copies submitted.

B. Submittals shall be transmitted or delivered directly to the office of the Engineer, as indicated in the Contact Documents or as otherwise directed by the Engineer.

C. Provide copies of transmittals (only, i.e., without copies of the respective submittal) directly to the Resident Project Representative.

3.03 PROCEDURES

A. ACTION SUBMITTALS

1. CONTRACTOR'S RESPONSIBILITIES

a. Coordination of Submittal Times: Prepare and transmit each submittal sufficiently in advance of performing the related work or other applicable activities, or within the time specified in the individual work of other related Sections, so that the installation will not be delayed by processing times including disapproval and resubmittal (if required). Coordinate with other submittals, testing, purchasing, fabrication, delivery and similar sequenced activities. Extensions to the Contract Time will not be approved for the Contractor's failure to transmit submittals sufficiently in advance of the Work.

b. The submittals of all shop drawings (including working drawings and product data) shall be sufficiently in advance of construction requirements to allow for possible need of re-submittals, including the specified review time for the Engineer.

c. No less than 30 calendar days will be required for Engineer's review time for shop drawings and O&M manuals involving only one engineering discipline. No less than 45 calendar days will be required for Engineer's review time for shop drawings and

O&M manuals that require review by more than one engineering discipline. Resubmittals will be subject to the same review time.

d. Submittals of operation and maintenance data shall be provided within 30 days of approval of the related shop drawing(s).

e. Before submission to the Engineer, review shop drawings as follows:

1) make corrections and add field measurements, as required

2) use any color for its notations except red (reserved for the Engineer's notations) and black (to be able to distinguish notations on black and white documents)

3) identify and describe each deviation or variation from Contract documents

4) include the required Contractor's Certification statement

5) provide field measurements (as needed)

6) coordinate with other submittals

7) indicate relationships to other features of the Work

8) highlight information applicable to the Work and/or delete information not applicable to the Work

f. Submit the following number of copies:

1) Shop drawings (including working drawings and product data) – Submit no fewer than six, and no more than nine; five of which will be retained by the Engineer.

2) Samples – three

3) Site Usage Plan – three copies

4) Schedule of values – five copies

5) Payment application format – five copies

g. If Contractor considers any correction indicated on the shop drawings to constitute a change to the Contract Documents, provide written notice thereof to the Engineer immediately; and do not release for manufacture before such notice has been received by the Engineer.

h. When the shop drawings have been completed to the satisfaction of the Engineer, carry out the construction in accordance therewith; and make no further changes therein except upon written instructions from the Engineer.

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2. ENGINEER'S RESPONSIBILITIES

   a. Engineer will not review shop drawings (including working drawings and product data) that do not include the Contractor's approval stamp. Such submittals will be returned to the Contractor, without action, for correction.

   b. Partial shop drawings (including working drawings and product data) will not be reviewed. If, in the opinion of the Engineer, a submittal is incomplete, that submittal will be returned to the Contractor for completion. Such submittals may be returned with comments from Engineer indicating the deficiencies requiring correction.

   c. If shop drawings (including working drawings and product data) meet the submittal requirements, Engineer will forward copies to appropriate reviewer(s). Otherwise, noncompliant submittals will be returned to the Contractor without action - with the Engineer retaining one copy.

   d. Submittals which are transmitted in accordance with the specified requirements will be reviewed by the Engineer within the time specified herein. The time for review will commence upon receipt of submittal by Engineer.

3. REVIEW OF SHOP DRAWINGS (INCLUDING WORKING DRAWINGS AND PRODUCT DATA) AND SAMPLES

   a. The review of shop drawings, working drawings, data and samples will be for general conformance with the design concept and Contract Documents. They shall not be construed:

      1) as permitting any departure from the Contract requirements

      2) as relieving the Contractor of responsibility for any errors, including details, dimensions, and materials

      3) as approving departures from details furnished by the Engineer, except as otherwise provided herein

   b. The Contractor remains responsible for details and accuracy, for coordinating the work with all other associated work and trades, for selecting fabrication processes, for techniques of assembly, and for performing work in a safe manner.

   c. If the shop drawings (including working drawings and product data) or samples as submitted describe variations and indicate a deviation from the Contract requirements that, in the opinion of the Engineer are in the interest of the Owner and are so minor as not to involve a change in Contract Price or Contract Time, the Engineer may return the reviewed drawings without noting an exception.

   d. Only the Engineer will utilize the color "RED" in marking submittals.

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e. Shop drawings will be returned to the Contractor with one of the following codes.

Code 1 – "APPROVED" – This code is assigned when there are no notations or comments on the submittal. When returned under this code the Contractor may release the equipment and/or material for manufacture.

Code 2 - "APPROVED AS NOTED" - This code is assigned when a confirmation of the notations and comments IS NOT required by the Contractor. The Contractor may release the equipment or material for manufacture; however, all notations and comments must be incorporated into the final product.

Code 3 - "APPROVED AS NOTED/CONFIRM" - This combination of codes is assigned when a confirmation of the notations and comments is required by the Contractor. The Contractor may release the equipment or material for manufacture; however, all notations and comments must be incorporated into the final product. This confirmation shall specifically address each omission and nonconforming item that was noted. Confirmation is to be received by the Engineer within 15 calendar days of the date of the Engineer's transmittal requiring the confirmation.

Code 4 - "APPROVED AS NOTED/RESUBMIT" - This combination of codes is assigned when notations and comments are extensive enough to require a resubmittal of the entire package. This resubmittal is to address all comments, omissions and non-conforming items that were noted. Resubmittal is to be received by the Engineer within 30 calendar days of the date of the Engineer's transmittal requiring the resubmittal.

Code 5 – "NOT APPROVED" – This code is assigned when the submittal does not meet the intent of the contract documents. The Contractor must resubmit the entire package revised to bring the submittal into conformance. It may be necessary to resubmit using a different manufacturer/vendor to meet the requirements of the contract documents.

Code 6 – "COMMENTS ATTACHED" – This code is assigned where there are comments attached to the returned submittal, which provide additional data to aid the Contractor.

Code 7 – "RECEIPT ACKNOWLEDGED (Not subject to Engineer's Review or Approval)" – This code is assigned to acknowledge receipt of a submittal that is not subject to the Engineer's review and approval, and is being filed for informational purposes only. This code is generally used in acknowledging receipt of means and methods of construction work plans, field conformance test reports, and health and safety plans.

Codes 1 through 5 designate the status of the reviewed submittal with Code 6 showing there has been an attachment of additional data.

f. REPETITIVE REVIEWS: Shop drawings, O&M manuals and other submittals will be reviewed no more than twice at the Owner's expense. All subsequent reviews will

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be performed at the Contractor's expense. Reimburse the Owner for all costs invoiced by Engineer for the third and subsequent reviews.

4. ELECTRONIC TRANSMISSION

a. ACTION SUBMITTALS may be transmitted by electronic means provided the following conditions are met:

1) The above-specified transmittal form is included.

2) All other requirements specified above have been met including, but not limited to, coordination by the Contractor, review and approval by the Contactor, and the Contractor's Certification.

3) The submittal contains no pages or sheets large than 11 x 17 inches.

4) With the exception of the transmittal sheet, the entire submittal is included in a single file.

5) The electronic files are PDF format (with printing enabled).

6) In addition, transmit three hard-copy (paper) originals to the Engineer in addition to any hard-copies that the Contractor wants to be returned.

7) The Engineer's review time will commence upon receipt of the hard copies of the submittal.

8) For Submittals that require certification, corporate seal, or professional embossment (i.e., P.E.s, Surveyors, etc.) transmit at least two hard-copy originals to the Engineer. In addition, provide additional photocopied or scanned copies, as specified above, showing the required certification, corporate seal, or professional seal.

B. INFORMATIONAL SUBMITTALS

1. CONTRACTOR'S RESPONSIBILITIES

a. Number of copies: Submit three copies, unless otherwise indicated in individual Specification sections

b. Refer to individual technical Specification Sections for specific submittal requirements.

2. ENGINEER'S RESPONSIBILITIES

a. The Engineer will review each informational submittal within 20 days. If the informational submittal complies with the Contract requirements, Engineer will file for the project record and transmit a copy to the Owner. Engineer may elect not to respond to Contractor regarding informational submittals meeting the Contract requirements.

b. If an informational submittal does not comply with the Contract requirements, Engineer will respond accordingly to the Contractor within 20 days. Thereafter, the Contractor shall perform the required corrective action, including retesting, if needed, until the submittal, in the opinion of the Engineer, is in conformance with the Contract Documents.

3. ELECTRONIC TRANSMISSION

a. INFORMATIONAL SUBMITTALS may be transmitted by electronic means providing all of the following conditions are met:

1) The above-specified transmittal form is included.

2) The submittal contains no pages or sheets large than 11 x 17 inches.

3) With the exception of the transmittal sheet, the entire submittal is included in a single file.

4) The electronic files are PDF format (printing enabled).

5) For Submittals that require certification, corporate seal, or professional embossment (i.e., P.E.s, Surveyors, etc.) transmit two hard-copy originals to the Engineer.

END OF SECTION

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## P.E. CERTIFICATION FORM

The undersigned hereby certifies that he/she is a professional engineer registered in the State of Arkansas and that he/she has been employed by

_____ to design
(Name of Contractor)

_____
(Insert P.E. Responsibilities)

In accordance with Specification Section _____ for the

Fourche Creek Wastewater Treatment Plant Improvements Project.

The undersigned further certifies that he/she has performed the said design in conformance with all applicable local, state and federal codes, rules and regulations; and, that his/her signature and P.E. stamp have been affixed to all calculations and drawings used in, and resulting from, the design.

The undersigned hereby agrees to make all original design drawings and calculations available to Little Rock Wastewater or Owner's representative within seven days following written request therefor by the Owner.

| | |
|---|---|
| _____ | _____ |
| P.E. Name | Contractor's Name |
| _____ | _____ |
| Signature | Signature |
| _____ | _____ |
| Address | Title |
| | _____ |
| | Address |

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SECTION 01310

CONSTRUCTION SCHEDULING

PART 1: GENERAL

1.01 PROJECT SCHEDULE

A. Purpose. The Project Schedule shall be the basis for evaluating all issues related to time for this contract. The Project Schedule shall at all times reflect the current plan for the timely execution and completion of work and shall document actual progress to date in accordance with the requirements of this section, utilizing the Critical Path Model (CPM) technique. The Engineer and the Contractor shall jointly utilize the Project Schedule for the following purposes:

1. to communicate to the Engineer the Contractor's intended operations for carrying out the work;
2. to identify work paths that are critical to the timely completion of the work;
3. to evaluate the best course of action for mitigating the impact of unforeseen events;
4. as a basis for all progress payments to the contractor;
5. as a reference in determining the costs associated with increases or decreases in the work;
6. as the basis for evaluating requests for time extension;
7. to prioritize Engineer review of submittals;
8. to document the actual progress of the work;
9. to facilitate cooperative efforts to complete the work; and
10. to determine the need for a recovery plan

B. The Project Schedule shall be utilized by the Contractor for management of this project. The Contractor shall provide a Project Scheduler who shall be involved from Notice to Proceed through Contract Completion.

1.02 QUALIFICATIONS

A. Have the capability of preparing and utilizing the specified CPM scheduling technique. A statement of CPM capability shall be submitted in writing to the Engineer within 15 days after the award of the Contract and will verify that either the Contractor's organization has in-house capability qualified to use the technique or that the Contractor employs a consultant who is so qualified. Capability shall be verified by description of the construction projects to which the Contractor or his/her consultant has successfully applied the CPM scheduling technique and which were controlled throughout the duration of the project by means of systematic use and

updating of a computer-based CPM schedule. The submittal shall include the name of the individual on the Contractor's staff who will be responsible for the CPM schedule and for providing the required updating information.

1.03 NETWORK REQUIREMENTS

A. The network shall show the order and inter-dependence of activities and the sequence in which the work is to be accomplished as planned by the Contractor. The basic concept of a network analysis diagram shall be followed to show how the start of a given activity is dependent on the completion of preceding activities and its completion restricts the start of following activities.

B. Detailed network activities shall include: construction activities, the submittal and approval of samples of materials and shop drawings, the procurement of materials and equipment, fabrication of materials and equipment and their delivery, installation and testing ,start-up and training. Break the work into activities with durations no longer than 20 working days each, except as to non-construction activities (such as procurement of materials and delivery of equipment) and any other activities for which the Engineer may approve the showing of longer duration. To the extent feasible, activities related to a specific physical area of the work shall be grouped on the network for ease of understanding and simplification.

C. Separate activities shall be provided for each significant identifiable function in each trade area in each facility. Activities shall be so identified that there will be no reasonable doubt as to how much work remains on each. Specific activities which shall be included are: all subcontract work, all interface work between subcontractors and between the Contractor and subcontractors, leakage tests of tanks and pipelines, electrical connections to each item of equipment, supplier and manufacturer technical assistance, mechanical connections to each item of equipment, all tests, concrete finishing, each item of site work, (including restraints on other activities) and all utilities, fuels and chemicals.

D. Each activity on the network shall have the following indicated on the NODE representing it.

1. A single duration (i.e., the single best estimate of elapsed time considering the scope of the work involved in the activity and the resources planned for accomplishing the activity) expressed in working days.

2. A five character (or less) code indicative of the party responsible for accomplishing the activity.

3. A cost estimate for each activity which, when accumulated with the cost of all activities, equals the total contract cost. Estimated overhead and profit shall be prorated throughout all activities. Materials costs shall be assigned to delivery activities.

4. A brief description of the activity.

E. The selection and number of activities shall be subject to the Engineer's approval. The detailed network need not be time scaled but shall be drafted to show a continuous flow from left to right with no flow from right to left. In addition to the brief description, submit a separate list of all activities containing a detailed narrative of the scope of each activity, including the trades and subcontractors involved and the number of man hours estimated.

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F. To the extent that the network or any revision thereof shows anything not jointly agreed upon or fails to show anything jointly agreed upon, it shall not be deemed to have been approved by the Engineer. Failure to include on a network any element of work required for the performance of this Contract shall not excuse the Contractor from completing all work required within any applicable completion date, notwithstanding the review of the network by the Engineer.

G. Except where earlier completions are specified, CPM schedules which show completion of all work prior to the contract completion date may be approved by the Engineer but in no event shall they be acceptable as a basis for claim for delay against the Owner by the Contractor.

1.04 COMPUTER-GENERATED SCHEDULE REQUIREMENTS

A. Each computer-generated schedule submittal from the CPM activity network shall include the following tabulations: a list of activities in numerical order, a list of activity precedence, a schedule sequenced by Early Start Date and a schedule sequenced by Total Float. Each schedule shall include the following minimum items:

1. Activity numbers
2. Estimated duration
3. Activity description
4. Early start date (calendar dated)
5. Early finish date (calendar dated)
6. Latest allowable start date (calendar dated)
7. Latest allowable finish date (calendar dated)
8. Status (whether critical)
9. Estimated cost of the activity
10. Total float and free float

B. In addition, each schedule shall be prefaced with the following summary data:

1. Contract name and number
2. Contractor's Name
3. Contract duration
4. Contract schedule
5. The effective or starting date of the schedule (the date indicated in the Notice to Proceed).

C. The work day to calendar date correlation shall be based on an 8-hour day and 40-hour week with adequate allowance for holidays, adverse weather and all other special requirements of the work.

1.05 INITIAL CONFERENCE

A. Within 15 days following the receipt of the Notice to Proceed, meet with the Engineer to discuss and agree on the proposed standards for the CPM schedule. At this conference submit to the Engineer a preliminary network defining the planned operations during the first 60 calendar days after Notice to Proceed. The general approach for the balance of the project shall be indicated. Cost of activities expected to be completed or partially completed before submission and approval of the complete network shall be included.

1.06 APPROVED CPM SCHEDULE

A. Within 45 days following the receipt of the Notice to Proceed, submit two prints of the proposed CPM activity network and a computer-generated schedule to the Engineer. Following review by the Engineer, the Contractor shall incorporate the Engineer's comments into the network and submit five prints and two reproducible of the revised network and two copies of the computer- generated schedule. This final submittal shall be delivered to the Engineer within 60 days after the Notice to Proceed.

B. CPM schedules which contain activities showing negative float or which extend beyond the contract completion date in the computer- generated schedule will not be approved.

C. Participate in the initial review and evaluation of the proposed network diagram and schedule by the Engineer. The approved network shall then be the approved CPM schedule to be used for planning, organizing and directing the work, and reporting progress.

D. Approval of the CPM activity network by the Engineer is advisory only and shall not relieve the Contractor of responsibility for accomplishing the work within the contract completion date. Omissions and errors in the approved CPM schedule shall not excuse performance less than that required by the Contract. Approval by the Engineer in no way makes the Engineer an insurer of the CPM schedule's success or liable for time or cost overruns flowing from its shortcomings. The Owner hereby disclaims any obligation or liability by reason of approval by its agent, the Engineer, of the CPM schedule.

E. The CPM activity network shall be prepared in accordance with the format used in the Preliminary Guideline CPM Schedule noted above. The network shall be submitted on sheets 11-in by 17-in and may be divided into as many separate sheets as required.

1.07 PROGRESS REPORTING

A. Progress under the approved CPM schedule shall be evaluated monthly by the Contractor and the Engineer. Not less than 7 days prior to each monthly progress meeting, they shall meet at the jobsite and jointly evaluate the status of each activity on which work has started or is due to start, based on the preceding CPM schedule; to show actual progress, to identify those activities started and those completed during the previous period, to show the estimated time required to complete or the percent complete of each activity started but not yet completed and to reflect any changes indicated for the network. Activities shall not be considered to be complete until they are, in fact, 100 percent complete.

B. The Contractor will produce from this evaluation, at no expense to the Owner, an updated computer-generated CPM schedule and CPM Status Report for the project.

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C. At each progress meeting, submit a narrative report based on the CPM schedule evaluation described above, in a format agreed upon by the Contractor and the Engineer. The report shall include a description of the progress during the previous period in terms of completed activities, an explanation of each activity which is showing a delay, a description of problem areas, current and anticipated delaying factors and their estimated impact on performance of other activities and completion dates and an explanation of corrective action taken or proposed. This report, as well as the CPM Status Report, will be discussed at each progress meeting.

1.08 RESPONSIBILITY FOR SCHEDULE COMPLIANCE

A. Whenever it becomes apparent from the current CPM schedule and CPM Status Report that delays to the critical path have resulted and the contract completion date will not be met, or when so directed by the Engineer, take some or all of the following actions at no additional cost to the Owner. Submit to the Engineer for approval, a written statement of the steps intended to take to remove or arrest the delay to the critical path in the approved schedule.

1. Increase construction manpower in such quantities and crafts as will substantially eliminate the backlog of work.

2. Increase the number of working hours per shift, shifts per day, working days per week, the amount of construction equipment, or any combination of the foregoing, sufficiently to substantially eliminate the backlog of work.

3. Reschedule activities to achieve maximum practical concurrence of accomplishment of activities and comply with the revised schedule.

B. If when so requested by the Engineer, failure to submit a written statement of the steps intended to take or should fail to take such steps as approved by the Engineer, the Engineer may direct the Contractor to increase the level of effort in man-power (trades), equipment and work schedule (overtime, weekend and holiday work, etc) to be employed by the Contractor in order to remove or arrest the delay to the critical path in the approved schedule and the Contractor shall promptly provide such level of effort at no additional cost to the Owner.

1.09 ADJUSTMENT OF CONTRACT SCHEDULE AND COMPLETION TIME

A. If the Contractor desires to make changes in his/her method of operating which affect the approved CPM schedule, he/she shall notify the Engineer in writing stating what changes are proposed and the reason for the change. If the Engineer approves these changes, the Contractor shall revise and submit for approval, without additional cost to the Owner, all of the affected portions of the CPM network. The CPM schedule shall be adjusted by the Contractor only after prior approval of his/her proposed changes by the Engineer. Adjustments may consist of changing portions of the activity sequence, activity durations, division of approved activities, or other adjustments as may be approved by the Engineer. The addition of extraneous, non-working activities and activities which add unapproved restraints to the CPM schedule shall not be approved.

B. If the completion of any activity, whether or not critical, falls more than 100 percent behind its approved duration, submit for approval a schedule adjustment showing each such activity divided into two activities reflecting completed versus uncompleted work.

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C. Shop drawings which are not approved on the first submittal or within the schedule time and equipment which do not pass the specified tests shall be immediately rescheduled.

D. The contract completion time will be adjusted only for causes specified in this Contract. In the event the Contractor requests an extension of any contract completion date, he/she shall furnish such justification and supporting evidence as the Engineer may deem necessary to determine whether the Contractor is entitled to an extension of time under the provisions of this Contract. The Engineer will, after receipt of such justification and supporting evidence, make findings of fact and will advise the Contractor in writing thereof. If the Engineer finds that the Contractor is entitled to any extension of any contract completion date, the Engineer's determination as to the total number of days extension shall be based upon the currently approved CPM schedule and on all data relevant to the extension. Such data shall be included in the next updating of the schedule. Actual delays in activities which, according to the CPM schedule, do not affect any contract completion date shown by the critical path in the network will not be the basis for a change therein.

E. Each request for change in any contract completion date shall be submitted by the Contractor to the Engineer within 30 days after the beginning of the delay for which a time extension is requested but before the date of final payment under this Contract. No time extension will be granted for requests which are not submitted within the foregoing time limit.

1. From time to time it may be necessary for the contract schedule or completion time to be adjusted by the Owner to reflect the effects of job conditions, weather, technical difficulties, strikes, unavoidable delays on the part of the Owner or its representatives and other unforeseeable conditions which may indicate schedule adjustments or completion time extensions. Under such conditions, the Engineer will direct the Contractor to reschedule the work or contract completion time to reflect the changed conditions and the Contractor shall revise his/her schedule accordingly. No additional compensation will be made to the Contractor for such schedule changes except for unavoidable overall contract time extensions beyond the actual completion of all unaffected work, in which case the Contractor shall take all possible action to minimize any time extension and any additional cost to the Owner. Available float time in the CPM schedule may be used by the Owner as defined by the Engineer, as well as by the Contractor.

F. The Owner controls the float time in the approved CPM network and, therefore, without obligation to extend either the overall completion date or any intermediate completion dates set out in the CPM network, the Owner may initiate changes to the work that absorb float time only. Owner initiated changes that affect the critical path on the approved CPM network shall be the sole grounds for extending (or contracting) said completion dates. Contractor-initiated changes that encroach on the float time identified in the approved CPM network may be accomplished with the Owner's concurrence. Such changes, however, shall give way to Owner-initiated changes competing for the same float time.

## 1.10 COORDINATING SCHEDULES WITH OTHER CONTRACT SCHEDULES

A. Where work is to be performed under this Contract concurrently with or contingent upon work performed on the same facilities or area under other contracts, the Contractor's CPM Schedule shall be coordinated with the schedules of the other contracts. Obtain the schedules of the other appropriate contracts from the Owner for the preparation and updating of the CPM

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schedule and make the required changes in the schedule when indicated by changes in corresponding schedules.

B. In case of interference between the operations of different contractors, the Owner will determine the work priority of each contractor and the sequence of work necessary to expedite the completion of the entire project. In all such cases, the decision of the Owner shall be accepted as final. The temporary delay of the Contractor's work due to such circumstances shall not be considered as justification for claims for additional compensation.

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SECTION 01370

SCHEDULE OF VALUES

PART 1: GENERAL

1.01 REQUIREMENTS INCLUDED

A. Submit a Schedule of Values allocated to the various portions of the work, within 21 days after the effective date of the Agreement.

B. Upon request of the Engineer, support the values with data which will substantiate their correctness.

C. The accepted Schedule of Values shall be used only as the basis for the Contractor's Applications for Payment.

1.02 RELATED REQUIREMENTS

A. Standard General Conditions of the Construction Contract are included in Section 00700.

B. Application for Payment is included in Section 01152.

1.03 FORM AND CONTENT OF SCHEDULE OF VALUES

A. Type schedule on an 8-1/2-in by 11-in or 8-1/2-in by 14-in white paper furnished by the Owner; Contractor's standard forms and automated printout will be considered for approval by the Engineer upon Contractor's request. Identify schedule with:

1. Title of Project and location.

2. Engineer and Project number.

3. Name and Address of Contractor.

4. Contract designation.

5. Date of submission.

B. Schedule shall list the installed value of the component parts of the work in sufficient detail to serve as a basis for computing values for progress payments during construction.

C. Identify each line item with the number and title of the respective Section.

D. For each major line item list sub-values of major products or operations under the item.

E. For the various portions of the work:

1. Each item shall include a directly proportional amount of the Contractor's overhead and profit.

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2. For items on which progress payments will be requested for stored materials, break down the value into:

   a. The cost of the materials, delivered and unloaded, with taxes paid. Paid invoices are required for materials upon request by the Engineer.

   b. The total installed value.

F. The sum of all values listed in the schedule shall equal the total Contract Sum.

1.04 SUBSCHEDULE OF UNIT MATERIAL VALUES

A. Submit a sub-schedule of unit costs and quantities for:

   1. Products on which progress payments will be requested for stored products.

B. The form of submittal shall parallel that of the Schedule of Values, with each item identified the same as the line item in the Schedule of Values.

C. The unit quantity for bulk materials shall include an allowance for normal waste.

D. The unit values for the materials shall be broken down into:

   1. Cost of the material, delivered and unloaded at the site, with taxes paid.

   2. Copies of invoices for component material shall be included with the payment request in which the material first appears.

   3. Paid invoices shall be provided with the second payment request in which the material appears or no payment shall be allowed and/or may be deleted from the request.

E. The installed unit value multiplied by the quantity listed shall equal the cost of that item in the Schedule of Values.

PART 2: PRODUCTS (NOT USED)

PART 3: EXECUTION (NOT USED)

END OF SECTION

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# SECTION 01380

# PHOTOGRAPHS

## PART 1: GENERAL

### 1.01 DESCRIPTION

A. Scope: This Section specifies photographs to be provided prior to, during, and after construction.

### 1.02 SUBMITTALS

A. Procedures: Section 01300.

B. Pre-construction, construction, and post construction photographs.

## PART 2: PRODUCTS

### 2.01 PHOTOGRAPHS

A. Photographs shall be taken on a digital camera and stored on CD or DVD with minimum resolution of 7 megapixels.

B. All digital files will be provided with a unique name describing the work and order or date each was taken (e.g., "secondary west plug valve 1.jpg" or "secondary west plug valve 2.jpg"). No file names shall be duplicated, regardless of file or order location.

C. One copy of the CDs or DVDs containing copies of the required photographs shall be presented to the Engineer and a second copy shall be presented to the Owner at each monthly progress meeting.

## PART 3: EXECUTION

### 3.01 GENERAL

A. Photographs shall be taken at locations disturbed or likely to be disturbed by construction or at locations designated by the Project Representative.

B. The photographer shall be equipped to photograph either interior or exterior exposures.

### 3.02 PRE-CONSTRUCTION PHOTOGRAPHS

A. Provide pre-construction photographs and video record prior to commencement of work on the site. Provide a minimum of five exposures of each area where the work is to take place.

B. No construction shall start until preconstruction photography is completed and submitted to the Engineer.

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3.02 CONSTRUCTION PHOTOGRAPHS

A. Provide construction photographs during the progress of the work. Take weekly exposures starting 1 week after the date of the preconstruction photographs and continuing as long as the work is in progress.

B. Photos may be required on a daily basis when the progression of the work will mask or prevent proper photographic recording of each phase of the work.

3.03 POST-CONSTRUCTION PHOTOGRAPHS

A. Take the number of exposures specified until Final Acceptance of the work.

3.05 REQUIRED NUMBER OF PHOTOGRAPHS

A. For the work of this Contract, photographic prints shall be provided as follow:

| Category | Amount of Photos |
|---|---|
| Pre-construction | 200 |
| Construction | 75 per week |
| Post-construction | 150 |

B. Unless identified by the Contractor specifically on the submittal, no disposition of the submittal by the Project Representative changes the requirements of the Specification and Drawings.

END OF SECTION

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SECTION 01445

# PIPELINE TESTING AND CLEANING

## PART 1 GENERAL

### 1.01 SCOPE OF WORK

A. Furnish all labor, materials, equipment and incidentals required and test and clean all new pipelines installed under this Contract as specified

### 1.02 RELATED WORK

A. Buried pipelines are included in Division 2.

B. Above grade and exposed pipelines are included in Division 15.

## PART 2 PRODUCTS (NOT USED)

## PART 3 EXECUTION

### 3.01 GENERAL

A. Furnish all necessary equipment and labor for cleaning and testing the pipelines. The procedures and methods shall be approved by the Engineer.

B. Make any taps and furnish all necessary caps, plugs, etc, as required in conjunction with testing pipelines. Furnish a test pump, gauges and any other equipment required in conjunction with carrying out the hydrostatic tests.

### 3.02 CLEANING PIPELINES

A. As pipe laying progresses and at the conclusion of the work thoroughly clean all new pipelines by flushing with water or other means to remove all dirt, stones, pieces of wood or other material which may have entered during the construction period. If, after this cleaning, obstructions remain, they shall be removed.

### 3.03 TESTING GRAVITY PIPELINES

A. All gravity pipelines shall be tested for leakage by an infiltration or exfiltration test. Buried piping shall be tested by an infiltration test if the groundwater is more than 2-ft above the crown of the pipe for the full length of the section to be tested. Air testing may be used in lieu of an exfiltration test subject to approval of the Engineer.

B. Exfiltration Test

1. Leakage tests by exfiltration shall be made by creating a head in the pipeline to be tested by filling the line and either a manhole or temporary riser on one end of the line with water. The length of pipe to be tested shall be such that the head over the crown at the upstream end is not less than 2-ft and the head over the downstream crown is not more than 6-ft. The pipe shall be plugged by pneumatic bags or mechanical plugs in such a manner that the air can be released from the pipe while it is being filled with water.

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Before any measurements are made, the pipe shall be kept full of water long enough to allow absorption and the escape of any trapped air to take place. Following this, a test period of at least one hour shall begin. Provisions shall be made for measuring the amount of water required to maintain the water at a constant level during the test period.

2. If any joint shows an appreciable amount of leakage, the jointing material shall be removed and the joint repaired. If any pipe is defective, it shall be removed and replaced. If the quantity of water required to maintain a constant head in the pipe does not exceed 1.9 gallons per inch of diameter per day per 100-ft of pipe and if all the leakage is not confined to a few joints, workmanship shall be considered satisfactory.

C. Infiltration Test

1. Pipe shall be tested for infiltration after the backfill has been placed and the ground water allowed to return to normal elevation. The length of line to be tested shall be not less than the length between adjacent manholes and not more than the total length of each size of pipe. The allowable infiltration shall be 1.9 gallons per inch of diameter per day per 100-ft of pipe in each section tested. There shall be no gushing or spurting leaks.

2. If an inspection of the completed pipeline or any part thereof shows pipes or joints which allow noticeable infiltration of water, the defective work or material shall be replaced or repaired as directed.

3. Rates of infiltration shall be determined by means of V-notch weirs, pipe spigots, or by plugs in the end of the pipe installed in an approved manner and at such times and locations as may be directed by the Engineer.

D. When the pipeline to be tested is reinforced concrete pipe, the allowable leakage in the above tests shall be 4.7 gallons per inch of diameter per 100-ft of pipe.

3.04 TESTING PRESSURE PIPELINES

A. All pressure pipelines shall be pressure and leakage tested. Pipelines shall be subjected to a hydrostatic pressure of 50 percent above the normal operating pressure and this pressure maintained for at least 10 minutes. The leakage test shall be conducted at the maximum operating pressure as determined by the Engineer, and this pressure shall be maintained for at least two hours. The test pump and water supply shall be arranged to allow accurate measurement of the water required to maintain the test pressure. Where applicable, hydrant branch gate valves shall remain open during this test. The amount of leakage which will be permitted shall be in accordance with AWWA C600.

END OF SECTION

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SECTION 01500

TEMPORARY FACILITIES

PART 1: GENERAL

1.01 TEMPORARY OFFICES

A. Temporary offices shall be established on the job site where approved or directed by the Engineer, adequately furnished, and maintained in a clean, orderly condition by the Contractor. The Contractor or an authorized representative shall be present in the field office at all times while work is in progress. Instructions received there from the Engineer shall be considered as delivered to the Contractor.

B. A temporary office has already been established on the site for the Owner's Representative. The costs associated with this facility should NOT be included in this Contract.

1.02 TEMPORARY LIGHT AND POWER

A. Furnish temporary light and power, including 220 Volt service for welding, complete with wiring, lamps and similar equipment as required to adequately light all work areas and with sufficient power capacity to meet the reasonable needs of all subcontractors. Make all necessary arrangements with the local electric company for temporary electric service and pay all expenses in connection therewith.

B. Provide properly configured NEMA polarized outlets to prevent insertion of 110-120 Volt plugs into higher voltage outlets. For connection of power tools and equipment, provide outlets equipped with ground-fault circuit interrupters, reset button and pilot light.

C. 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 more than one length is required.

D. Provide general service incandescent lamps as required for adequate illumination. Provide guard cages or tempered glass enclosures where exposed to breakage. Provide exterior fixtures where exposed to moisture.

1.03 TEMPORARY HEAT

A. Provide all heat as may be necessary for thawing out and heating the ground or materials and for proper execution, protection and drying out the of work.

1.04 TEMPORARY AIR AND WATER

A. The Contractor shall provide all air, including piping and appurtenances required for testing pipelines, structures, and equipment.

B. Water for testing purposes shall be provided by the Owner. All labor, equipment and piping to connect to Owner-designated water sources shall be provided by Contractor.

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C. Remove temporary piping and appurtenances on completion of testing.

1.05 TEMPORARY SANITARY FACILITIES

A. Provide self-contained, single-occupant toilet units of the chemical or aerated recirculation, properly vented and fully enclosed in a fiberglass or other approved non-absorbent shell.

B. Contractor's personnel and guests shall not have access to Owner's restrooms.

1.06 FIRE EXTINGUISHERS

A. Provide portable UL-rated, Class A fire extinguishers for temporary offices and similar spaces. In other locations, provide portable UL-rated Class ABC dry chemical extinguishers or a combination of NFPA recommended Classes for the exposure. Comply with NFPA 10 and 241 for classification, extinguishing agent and size required by location and class of fire exposure.

1.07 LAYOUT OF TEMPORARY FACILITIES

A. Before starting the work, the Contractor shall submit to the Engineer his requirements for space for temporary structures (if required) and storage of materials. Where onsite space for temporary facilities is limited, the allocation of the available space will be made by the Engineer. Should the Contractor require space in addition to that allocated, the Contractor shall make his own arrangements for storage of materials and equipment in locations off the construction site. For the allocated space, the Contractor shall submit to the Engineer for approval, his proposed plan and layout for all temporary offices, sanitary facilities, temporary construction roads, storage buildings, storage yards, temporary water service and distribution, temporary power service and distribution, and temporary telephone service.

1.08 STORAGE YARDS

A. The Contractor shall construct temporary storage yards for the storage of materials that are not subject to damage by weather conditions. Materials such as pipe and reinforcing and structural steel shall be stored on pallets or racks, off the ground, and in a manner that allows ready access for inspection and inventory. Temporary gravel surfacing of the storage yards shall meet with the approval of the Engineer.

1.09 CONTRACTORS WORK AREA

A. The Contractor will be working in a fully operational Wastewater Treatment Plant. All Contractor active working areas will be flagged and safety precautions taken to protect Owner plant personnel.

B. The Contractor shall limit his operations and storage of equipment and materials to the areas designated and as directed by the Engineer.

C. Except as provided herein, no sidewalk, private property, or other area adjacent to the plant site shall be used for storage of the Contractor's equipment and materials unless prior written approval is obtained from the legal owner.

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D. The Contractor shall maintain the area during construction in a manner that will not obstruct plant operations and maintenance. He shall proceed with his work in an orderly manner, maintaining the construction site free of debris and unnecessary equipment or materials.

E. At all times, maintain areas covered by the Contract and public properties free from accumulations of waste, debris, and rubbish caused by construction operations.

F. Excavated materials shall be removed from the site in a manner that will cause the least damage to adjacent grassed areas, trees, or fences.

G. Cleaning and disposal operations shall comply with local ordinances and antipollution laws. Do not burn or bury rubbish and waste materials on the project site. Do not dispose of volatile wastes such as mineral spirits, oil, chemicals, or paint thinner in storm or sanitary drains. Do not dispose of wastes into streams or waterways.

H. Wet down dry materials and rubbish to allay dust and prevent blowing dust.

I. Provide approved containers for collection and disposal of waste materials, debris, and rubbish and make arrangements for appropriate periodic emptying of the containers.

J. The Contractor shall furnish, install and maintain temporary heat and enclosures to provide adequate working areas for personnel. The Contractor shall furnish temporary heating units that have been tested and labeled by UL, FM or other recognized association related to the type of fuel being used, and maintain reasonable temperatures within the temporary enclosures.

## 1.10 TEMPORARY ACCESS ROADS AND PARKING SPACE

A. The Contractor shall construct temporary construction access roads and detours as are required to execute the work. The roads shall meet with the approval of the Engineer, and be maintained in good condition until no longer needed; at which time the temporary roads shall be removed and the area left in a condition satisfactory to the Engineer. The Operation and Maintenance of the Treatment Plant must not be interrupted during construction of this project.

B. The Contractor shall construct temporary parking facilities for his employees, his Sub-Contractor's employees, other employees and the Engineer.

## 1.11 PROTECTION OF THE FINISHED CONSTRUCTION

A. The Contractor shall assume the responsibility for the protection of all finished construction and shall repair and restore any and all damage to finished work to its original or better state.

B. Where responsibility can be determined, the cost for replacement or repair of damaged work shall be charged to the party responsible. If responsibility cannot be fixed, the cost shall be borne by the Contractor.

C. Wheeling of any loads over finished floors, either with or without plank protection, shall not be permitted in anything except rubber-tired wheelbarrows, buggies, trucks, or dollies. This applies to all finished floors and to all exposed concrete floors as well as those covered with composition tile or other applied surfacing, and shall apply to all trades.

D. Where structural concrete is also the finished surface, care shall be taken to avoid marking or damaging those surfaces.

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1.12 REMOVAL OF TEMPORARY FACILITIES AND UTILITIES

A. At such time or times any temporary construction facilities and utilities are no longer required for the work, the Contractor shall notify the Engineer of his intent and schedule for removal of the temporary facilities and utilities, and obtain the Engineer's approval before removing the same. As approved, the Contractor shall disconnect and/or dismantle the temporary facilities and utilities and remove them from the site as his property. Leave the site in such condition as specified, as directed by the Engineer, and/or as shown on the Plans.

B. In unfinished areas, the condition of the site shall be left in a condition that will restore original drainage, evenly graded, seeded or planted as necessary, and left with an appearance equal to, or better than original.

1.13 PAYMENT

A. The work specified in this Section shall be considered incidental and payment will be included as part of the appropriate lump sum or unit prices stated in the Proposal.

PART 2: PRODUCTS (NOT USED)

PART 3: EXECUTION (NOT USED)

END OF SECTION

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SECTION 01562

DUST CONTROL

PART 1 GENERAL

1.01 SCOPE OF WORK

A. Perform dust control operations and limit blowing dust caused by construction operations in an approved manner, whenever necessary or when directed by the Engineer. Dust control shall be generally accomplished by the use of water, disinfected secondary effluent (Plant Water) or employing other appropriate means or methods to maintain dust control, subject to approval of the Owner.

B. Methods of controlling dust shall meet all air pollutant standards as set forth by Federal and State regulatory agencies.

1.02 PROTECTION OF ADJACENT PROPERTY

A. The Bidders shall visit the site and note the buildings, landscaping, roads, parking areas and other facilities near the Work sites that may be damaged by their operations. The Contractor shall make adequate provision to fully protect the surrounding area and will be held fully responsible for all damages resulting from Contractor's operations.

B. Protect all existing facilities (indoors or out) from damage by dust, fumes, spray or spills (indoors or out). Protect all existing facilities, equipment and/or other surfaces from dirt, dust, welding fumes, paint spray, spills or droppings causing wear, corrosion, malfunction, failure or defacement by enclosure, sprinkling or other dust palliatives, masking and covering, exhausting or containment.

C. Care shall be taken to prevent any disinfected secondary effluent used for dust control from discharging offsite.

D. The Contractor shall not discharge water from dust control operations directly into any stream, channel, wetlands or surface water.

PART 2: PRODUCTS (NOT USED)

PART 3: EXECUTION

3.01 DUST CONTROL

A. Water for dust control shall be taken from the existing plant water or potable water system. All plant water used for dust control shall be positively controlled until the site is completely vegetated with grass.

B. The use of plant water for equipment and truck wash down shall only be allowed in designated areas approved by the Engineer and Owner where the water can be captured in the plant storm drain system.

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C. Positive preventive measures shall be taken to avoid spillage of plant water. In the event of any spillage, prompt remedial action shall be taken in accordance with a contingency action plan meeting the approval of applicable authorities. Contractor shall submit two copies of approved contingency plans to the Engineer.

END OF SECTION

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SECTION 01580

# PROJECT IDENTIFICATION AND SIGNS

## PART 1: GENERAL

### 1.01 REQUIREMENTS

A. Furnish, install and maintain project identification sign.

B. Remove sign on completion of construction.

C. Allow no other signs to be displayed.

### 1.02 RELATED WORK

A. Rough Carpentry is included in Section 06100.

### 1.03 SUBMITTALS

A. Submit in accordance with the requirements of Section 01300.

### 1.04 PROJECT IDENTIFICATION SIGN

A. One painted sign, of not less than 32 square feet (3 square meters) area, with painted graphic content to include:

1. Title of Project.
2. Name of Owner.
3. Names and titles of authorities:
4. Names and title of:
    a. Engineer.
    b. Professional Consultants.
5. Prime Contractor.
6. Major subcontractors.

B. Graphic design, style of lettering and colors: As approved by the Engineer and subject to the approval of the local Community Appearance Board (CAB) or its equivalent and applicable local regulations for signs.

C. Erect on the site at a lighted location of high public visibility, adjacent to main entrance to site, as approved by the Engineer and the Owner.

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1.05 INFORMATIONAL SIGNS

A. Painted signs with painted lettering, or standard products.

1. Size of signs and lettering: as required by regulatory agencies, or as appropriate to usage.

2. Colors: as required by regulatory agencies, otherwise of uniform colors throughout Project.

B. Erect at appropriate location to provide required information.

1.06 QUALITY ASSURANCE

A. Sign Painter: Professional Experience in type of work required.

B. Finishes, Painting: Adequate to resist weathering and fading for scheduled construction period.

PART 2: PRODUCTS

2.01 SIGN MATERIALS

A. Structure and Framing: May be new or used, wood or metal, in sound condition structurally adequate to work and suitable for specified finish.

B. Sign Surfaces: Exterior softwood plywood with medium density overlay, standard large sizes to minimize joints.

1. Thickness: As required by standards to span framing members, to provide even, smooth surface without waves or buckles.

C. Rough Hardware: Galvanized

D. Paint: Exterior quality, as specified in Division 9.

1. Use Bulletin colors for graphics.

2. Colors for structure, framing, sign surfaces and graphics: As selected by the Engineer.

PART 3: EXECUTION

3.01 PROJECT IDENTIFICATION SIGN

A. Paint exposed surfaces of supports, framing and surface material; one coat of primer and one coat of exterior paint.

B. Paint graphics in styles, sizes and colors selected.

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3.02 MAINTENANCE

A. Maintain signs and supports in a neat, clean condition; repair damages to structure, framing or sign.

3.03 REMOVAL

A. Remove signs, framing, supports and foundations at completion of project.

END OF SECTION

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SECTION 01600

# DELIVERY, STORAGE AND HANDLING

## PART 1: GENERAL

### 1.01 SCOPE OF WORK

A. This Section specifies the general requirements for the delivery handling, storage and protection for all items required in the construction of the work. Specific requirements, if any, are specified with the related item.

### 1.02 TRANSPORTATION AND DELIVERY

A. Transport and handle items in accordance with manufacturer's instructions.

B. Schedule delivery to reduce long term on-site storage prior to installation and/or operation. Under no circumstances shall equipment be delivered to the site more than one month prior to installation without written authorization from the Engineer.

C. Coordinate delivery with installation to ensure minimum holding time for items that are hazardous, flammable, easily damaged or sensitive to deterioration.

D. Deliver products to the site in manufacturer's original sealed containers or other packing systems, complete with instructions for handling, storing, unpacking, protecting and installing.

E. All items delivered to the site shall be unloaded and placed in a manner which will not hamper the Contractor's normal construction operation or those of subcontractors and other contractors and will not interfere with the flow of necessary traffic.

F. Provide necessary equipment and personnel to unload all items delivered to the site.

G. Promptly inspect shipment to assure that products comply with requirements, quantities are correct and items are undamaged. For items furnished by others (i.e. Owner, other Contractors), perform inspection in the presence of the Engineer. Notify Engineer verbally, and in writing, of any problems.

H. If any item has been damaged, such damage shall be repaired at no additional cost to the Owner.

### 1.03 STORAGE AND PROTECTION

A. Store and protect products in accordance with the manufacturer's instructions, with seals and labels intact and legible. Storage instruction shall be studied by the Contractor and reviewed with the Engineer by him/her. Instruction shall be carefully followed and a written record of this kept by the Contractor. Arrange storage to permit access for inspection.

B. Store loose granular materials on solid flat surfaces in a well-drained area. Prevent mixing with foreign matter.

C. Cement and lime shall be stored under a roof and off the ground and shall be kept completely dry at all times. All structural, miscellaneous and reinforcing steel shall be stored off the ground or otherwise to prevent accumulations of dirt or grease and in a position to prevent accumulations of standing water and to minimize rusting. Beams shall be stored with the webs vertical. Precast concrete shall be handled and stored in a manner to prevent accumulations of dirt, standing water, staining, chipping or cracking. Brick, block and similar masonry products shall be handled and stored in a manner to reduce breakage, cracking and spalling to a minimum.

D. All mechanical and electrical equipment and instruments subject to corrosive damage by the atmosphere if stored outdoors (even though covered by canvas) shall be stored in a weathertight building to prevent injury. The building may be a temporary structure on the site or elsewhere, but it must be satisfactory to the Engineer. Building shall be provided with adequate ventilation to prevent condensation. Maintain temperature and humidity within range required by manufacturer.

1. All equipment shall be stored fully lubricated with oil, grease and other lubricants unless otherwise instructed by the manufacturer.

2. Moving parts shall be rotated a minimum of once weekly to ensure proper lubrication and to avoid metal-to-metal "welding". Upon installation of the equipment, the Contractor shall start the equipment, at least half load, once weekly for an adequate period of time to ensure that the equipment does not deteriorate from lack of use.

3. Lubricants shall be changed upon completion of installation and as frequently as required thereafter during the period between installation and acceptance. New lubricants shall be put into the equipment at the time of acceptance.

4. Prior to acceptance of the equipment, the Contractor shall have the manufacturer inspect the equipment and certify that its condition has not been detrimentally affected by the long storage period. Such certifications by the manufacturer shall be deemed to mean that the equipment is judged by the manufacturer to be in a condition equal to that of equipment that has been shipped, installed, tested and accepted in a minimum time period. As such, the manufacturer will guaranty the equipment equally in both instances. If such a certification is not given, the equipment shall be judged to be defective. It shall be removed and replaced at the Contractor's expense.

E. All paint and other coating products shall be stored in areas protected from the weather. Follow all storage requirements set forth by the paint and coating manufacturers.

END OF SECTION

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SECTION 01601

CONTROL OF MATERIALS

PART 1: GENERAL

1.01 SCOPE OF WORK

A. This Section specifies the general requirements for the approval, delivery, handling, storage and protection for all items required in the construction of the work. Specific requirements, if any, are specified with the related item.

1.02 TRANSPORTATION AND DELIVERY

A. Transport and handle items in accordance with manufacturer's instructions.

B. Schedule delivery to reduce long term on-site storage prior to installation and/or operation. Under no circumstances shall equipment be delivered to the site more than one month prior to installation without written authorization from the Engineer.

C. Coordinate delivery with installation to ensure minimum holding time for items that are hazardous, flammable, easily damaged or sensitive to deterioration.

D. Deliver products to the site in manufacturer's original sealed containers or other packing systems, complete with instructions for handling, storing, unpacking, protecting and installing.

E. All items delivered to the site shall be unloaded and placed in a manner which will not hamper the Contractor's normal construction operation or those of subcontractors and other contractors and will not interfere with the flow of necessary traffic.

F. Provide necessary equipment and personnel to unload all items delivered to the site.

G. Promptly inspect shipment to assure that products comply with requirements, quantities are correct and items are undamaged. For items furnished by others (i.e. Owner, other Contractors), perform inspection in the presence of the Engineer. Notify Engineer verbally, and in writing, of any problems.

1.03 APPROVAL OF MATERIALS

A. Unless otherwise specified, only new materials and equipment shall be incorporated in the work. All materials and equipment furnished shall be subject to the inspection and approval of the Engineer. No material shall be delivered to the work without prior approval of the Engineer.

B. Submit, in accordance with Section 01300, data relating to materials and equipment proposed to be furnished for the work. Such data shall be in sufficient detail to enable the Engineer to identify the particular product and to form an opinion as to its conformity to the specifications.

C. Facilities and labor for handling and inspection of all materials and equipment shall be furnished by the Contractor. If the Engineer requires, either prior to beginning or during the progress of the work, submit additional samples or materials for such special tests as may be necessary to demonstrate that they conform to the requirements specified herein. Such samples shall be furnished, stored, packed and shipped as directed at the Contractor's expense. Except as otherwise noted, the Owner will make arrangements for and pay for the tests.

D. Any delay of approval resulting from the Contractor's failure to submit samples or data promptly shall not be used as a basis of a claim against the Owner or the Engineer.

E. In order to demonstrate the proficiency of workmen or to facilitate the choice among several textures, types, finishes and surfaces, provide such samples of workmanship or finish as may be required.

F. The materials and equipment used on the work shall correspond to the approved samples or other data.

1.04 STORAGE AND PROTECTION

A. Store and protect products in accordance with the manufacturer's instructions, with seals and labels intact and legible. Storage instruction shall be studied by the Contractor and reviewed with the Engineer by him/her. Instruction shall be carefully followed and a written record of this kept by the Contractor. Arrange storage to permit access for inspection.

B. Store loose granular materials on solid flat surfaces in a well-drained area. Prevent mixing with foreign matter.

C. Cement and lime shall be stored under a roof and off the ground and shall be kept completely dry at all times. All structural, miscellaneous and reinforcing steel shall be stored off the ground or otherwise to prevent accumulations of dirt or grease and in a position to prevent accumulations of standing water and to minimize rusting. Beams shall be stored with the webs vertical. Precast concrete shall be handled and stored in a manner to prevent accumulations of dirt, standing water, staining, chipping or cracking. Brick, block and similar masonry products shall be handled and stored in a manner to reduce breakage, cracking and spalling to a minimum.

D. All mechanical and electrical equipment and instruments subject to corrosive damage by the atmosphere if stored outdoors (even though covered by canvas) shall be stored in a weathertight building to prevent injury. The building may be a temporary structure on the site or elsewhere, but it must be satisfactory to the Engineer. Building shall be provided with adequate ventilation to prevent condensation. Maintain temperature and humidity within range required by manufacturer.

1. All equipment shall be stored fully lubricated with oil, grease and other lubricants unless otherwise instructed by the manufacturer.

2. Moving parts shall be rotated a minimum of once weekly to ensure proper lubrication and to avoid metal-to-metal "welding". Upon installation of the equipment, the Contractor shall start the equipment, at least half load, once weekly for an adequate period of time to ensure that the equipment does not deteriorate from lack of use.

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3. Lubricants shall be changed upon completion of installation and as frequently as required thereafter during the period between installation and acceptance. New lubricants shall be put into the equipment at the time of acceptance.

4. Prior to acceptance of the equipment, the Contractor shall have the manufacturer inspect the equipment and certify that its condition has not been detrimentally affected by the long storage period. Such certifications by the manufacturer shall be deemed to mean that the equipment is judged by the manufacturer to be in a condition equal to that of equipment that has been shipped, installed, tested and accepted in a minimum time period. As such, the manufacturer will guaranty the equipment equally in both instances. If such a certification is not given, the equipment shall be judged to be defective. It shall be removed and replaced at the Contractor's expense.

PART 2: PRODUCTS (NOT USED)

PART 3: EXECUTION (NOT USED)

END OF SECTION

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SECTION 01700

CONTRACT CLOSEOUT

PART 1: GENERAL

1.01 SCOPE OF WORK

A. This Section specifies administrative and procedural requirements for project closeout, including but not limited to:

1. Closeout procedures.

2. Final cleaning.

3. Adjusting.

4. Project record documents.

5. Spare parts and maintenance materials.

1.02 RELATED WORK

A. Warranties and Bonds are included in Section 01740.

B. Project Record Documents are included in Section 01720.

1.03 CLOSEOUT PROCEDURES

A. Submit written certification that Contract Documents have been reviewed, work has been inspected and that work is complete in accordance with Contract Documents and ready for Engineer's inspection.

B. Provide submittals to Engineer that are required by governing or other authorities.

C. Submit Application for Final Payment identifying total adjusted Contract Sum, previous payments and sum remaining due.

1.04 FINAL CLEANING

A. Complete the following cleaning operations before requesting inspection for Certification of Substantial Completion.

1. Remove labels that are not permanent labels.

2. The installing Prime Contractor and or Subcontractor shall 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.

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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. The installing Prime Contractor and or Subcontractor shall wipe surface 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 the site, including landscape development areas, of rubbish, litter and other 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.

1.05 ADJUSTING

A. Adjust operating products and equipment to ensure smooth and unhindered operation.

PART 2: PRODUCTS (NOT USED)

PART 3: EXECUTION (NOT USED)

END OF SECTION

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SECTION 01710

CLEANING

PART 1: GENERAL

1.01 SCOPE OF WORK

A. Execute cleaning, during progress of the work, and at completion of the work, as required by General Conditions.

1.02 RELATED WORK

A. Standard General Conditions of the Construction Contract are included in Section 00700.

B. Each Section: Cleaning for specific products or work.

1.03 DISPOSAL AND CLEANING

A. Conduct cleaning and disposal operations to comply with codes, ordinances, regulations and anti-pollution laws.

PART 2: PRODUCTS

2.01 MATERIALS

A. Use only those cleaning materials which will not create hazards to health or property and which will not damage surfaces.

B. Use only those cleaning materials and methods recommended by manufacturer of the surface material to be cleaned.

C. Use cleaning materials only on surfaces recommended by cleaning material manufacturer.

PART 3: EXECUTION

3.01 DURING CONSTRUCTION

A. Execute periodic cleaning to keep the work, the site and adjacent properties free from accumulations of waste materials, rubbish and windblown debris, resulting from construction operations.

B. Provide on-site containers for the collection of waste materials, debris and rubbish.

C. Remove waste materials, debris and rubbish from the site periodically and dispose of at legal disposal areas away from the site.

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3.02 DUST CONTROL

A. Clean interior spaces prior to the start of finish painting and continue cleaning on an as-needed basis until painting is finished.

B. Schedule operations so that dust and other contaminants resulting from cleaning process will not fall on wet or newly-coated surfaces.

3.03 FINAL CLEANING

A. Employ skilled workmen for final cleaning.

B. Remove grease, mastic, adhesives, dust, dirt, stains, fingerprints, labels and other foreign materials from sight-exposed interior and exterior surfaces.

C. Wash and shine glazing and mirrors.

D. Polish glossy surfaces to a clear shine.

E. Ventilating Systems:

1. Clean permanent filters and replace disposable filters if units were operated during construction.

2. Clean ducts, blowers and coils if units were operated without filters during construction.

F. Broom clean exterior paved surfaces; rake clean other surfaces of the grounds.

G. Prior to final completion, or Owner occupancy, conduct an inspection of sight-exposed interior and exterior surfaces and all work areas, to verify that the entire work is clean.

END OF SECTION

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SECTION 01730

# OPERATION AND MAINTENANCE DATA

## PART 1: GENERAL

### 1.01 SCOPE OF WORK

A. This Section includes procedural requirements for compiling and submitting operation and maintenance data required to complete the project.

### 1.02 RELATED WORK

A. Submittals are included in Section 01300

B. Contract closeout is included in Section 01700

C. Warranties and Bonds are included in Section 01740

### 1.03 OPERATING MANUALS

A. Provide operation and maintenance instructions for all electrical, mechanical, and instrumentation & controls equipment furnished under various technical specifications Sections.

B. Separate manuals shall be provided for each type of equipment, or each Section number. Each manual shall contain the following:

1. Format and Materials

a. Binders:

1) Commercial quality three ring binders with durable and cleanable plastic covers

2) Maximum ring width capacity: 3 inches

3) When multiple binders are used, correlate the data into related consistent groupings/volumes.

b. Identification: Identify each volume on the cover and spine with typed or printed title "OPERATING AND MAINTENANCE INSTRUCTIONS". Include the following:

1) Title of Project.

2) Identify the general subject matter covered in the manual

3) Identify structure(s) and/or location(s), as applicable

4) Specification Section number

c. 20 lb loose leaf paper, with hole reinforcement

d. Page size: 8-1/2 inch by 11 inch

e. Provide heavy-duty fly leafs (section separators), matching the table of contents, for each separate product, each piece of operating equipment, and organizational sections of the manual.

f. Provide reinforced punched binder tab; bind in with text.

g. Reduce larger drawings and fold to the size of text pages - but not larger than 11 inches x 17 inches - or provide a suitable clear plastic pocket (with drawing identification) for such folded drawings/diagrams.

2. Contents:

a. A table of contents/Index

b. Specific description of each system and components

c. Name, address, telephone number(s) and e-mail address(es) of vendor(s) and local service representative(s)

d. Specific on-site operating instructions (including starting and stopping procedures)

e. Safety considerations

f. Project specific operational procedures

g. Project specific maintenance procedures

h. Manufacturer's operating and maintenance instructions – specific to the project

i. Copy of each wiring diagram

j. Copy of approved shop drawing(s) and Contractor's coordination/layout drawing(s)

k. List of spare parts and recommended quantities

l. Product Data: Mark each sheet to clearly identify specific products and component parts and data applicable to installation. Delete inapplicable information.

m. Drawings: Supplement product data to illustrate relations of component parts of equipment and systems, to show control and flow diagrams

n. Provide logical sequence of instructions for each procedure, incorporating manufacturer's instructions specified.

o. Warranties and Bonds, as specified in the General Conditions

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3. Transmittals

   a. Prepare separate transmittal sheets for each manual. Each transmittal sheet shall include al least the following: the Contractor's name and address, Owner's name, project name, project number, submittal number, description of submittal and number of copies submitted.

   b. Submittals shall be transmitted or delivered directly to the office of the Engineer, as indicated in the Contact Documents or otherwise directed by the Engineer.

   c. Provide copies of transmittals (only, i.e., without copies of the respective submittal) directly to the Resident Project Representative.

C. Manuals for Equipment and Systems - In addition to the requirements listed above, for each System, provide the following:

1. Overview of system and description of unit or system and component parts. Identify function, normal operating characteristics and limiting conditions. Include performance curves, with engineering data and tests and complete nomenclature and commercial number of replaceable parts.

2. Panelboard circuit directories including electrical service characteristics, controls and communications and color coded wiring diagrams as installed.

3. Operating procedures: include start-up, break-in and routine normal operating instructions and sequences; regulation, control, stopping, shut-down and emergency instructions; and summer, winter and any special operating instructions.

4. Maintenance Requirements

   a. Procedures and guides for trouble-shooting; disassembly, repair, and reassembly instructions

   b. Alignment, adjusting, balancing and checking instructions

   c. Servicing and lubrication schedule and list of recommended lubricants

   d. Manufacturer's printed operation and maintenance instructions

   e. Sequence of operation by instrumentation and controls manufacturer

   f. Original manufacturer's parts list, illustrations, assembly drawings and diagrams required for maintenance

5. Control diagrams by controls manufacturer as installed (as-built)

6. Contractor's coordination drawings, with color coded piping diagrams, as installed (as-built)

7. Charts of valve tag numbers, with location and function of each valve, keyed to flow and control diagrams. Include equipment and instrument tag numbers on diagrams

8. List of original manufacturer's spare parts and recommended quantities to be maintained in storage

9. Test and balancing reports, as required

10. Additional Requirements as specified in individual product specification

11. Design data for systems engineered by the Contractor or its Suppliers

D. Electronic Transmission of O&M Manuals

1. Unless otherwise approved by the Engineer, O&M manuals may not be transmitted by electronic means other than by CD-ROM. Electronic O&M manuals shall meet the following conditions:

   a. The above-specified transmittal form is included.

   b. All other requirements specified above have been met, including, but not limited to, coordination by the Contractor, review and approval by the Contactor.

   c. The submittal contains no pages or sheets large than 11 x 17 inches.

   d. With the exception of the transmittal sheet, the entire submittal is included in a single file.

   e. Files are Portable Document Format (PDF) – with the printing function enabled.

2. When electronic copies are provided, transmit two hard-copy (paper) originals to the Engineer with an electronic copy on CD-ROM.

3. The electronic copy of the O&M manual must be identical in organization, format and content to the hard copies of the manual.

1.04 SERVICES OF MANUFACTURERS' REPRESENTATIVE

A. All electrical, mechanical, and instrumentation & controls equipment furnished under various technical specifications Sections shall include the cost of a competent representative of the manufacturers of all equipment to supervise the installation, adjustment and testing of the equipment; and, to instruct the Owner's operating personnel on operation and maintenance. This supervision may be divided into two or more time periods to suit the Contractor's schedule and/or the Owner's personnel availability.

B. See the detailed specifications for additional requirements for furnishing the services of manufacturer's representatives.

C. The manufacturer's representative shall certify that the installation of the equipment is satisfactory; that the unit has been satisfactorily tested; that the equipment is ready for

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operation; and, that the operating personnel have been suitably instructed in the operation, maintenance, care, and safe operation of the equipment. The Equipment Manufacturer's Certificate of Installation, Testing, and Instruction attached to this Section shall be used for this certification.

D. For other materials furnished under other specification Sections, furnish the services of approved representative(s) of the manufacturer when, in the opinion of the Engineer, some evident product failure or malfunction makes such services necessary.

1.05 INTERACTIVE ONLINE TRAINING

A. Online Learning Modules will be developed; quizzes and a test will be prepared with the full cooperation of the manufacturers. Course work, Hosting services and Programming will be provided by 360water, Inc. or equal. Suppliers must have provided the LMS to 10 municipal clients and been in business for 5 years. The supplier will furnish the modules direct to the General Contractor for the owner not directly to the equipment manufacturer.

B. The Modules will be able to evaluate and test the operators on:

1. Start-up /Shut down of equipment
2. Basic operations, maintenance, and safety
3. Trouble shooting techniques

C. The Online Education Program will include the following functions:

1. Intermittent Quizzes and Test Questions;
2. Wrong answer notification;
3. 100% proficiency is required before a certificate of completion is generated;
4. A real time clock on screen that verifies the time spent on the course material;
5. The software program will automatically bookmark when the operator leaves a course (in case of power outage or an emergency in the facility).
6. The online education program needs to be approved by the state-regulating agency for continuing education. This is in the event of the facility choosing to apply for CH/CEU credits for their training program.

D. Equipment supplied in the following Specification Sections shall be included as part of the Interactive Online Training. Coordination must be made with the Contractor and their respective Equipment Suppliers for the following specification sections:

11238 Algae Sweep System
11282 Slide and Weir Gates
11285 Sluice Gates
11315 Secondary Clarifier Scum Pumps
11316 Sump Pumps

11317 Dry Pit Submersible Pumps (RAS/WAS Pumps)
11318 Internal Recycle Pumps
11352 Secondary Clarifier Sludge and Scum Collection Equipment
11370 Large Bubble Compressed Air Mixing System
11375 Disc-Type Fine Bubble Diffuser

1. The manufacturers will provide all relevant information needed to train a new operator on mandatory procedures. Review of Online Training: The Manufacturers will be required to review the courseware written for equipment they are supplying. Comments and corrections will be required within a schedule determined by the contractor.

2. The hosting of this service shall last a minimum of 10-years. A Hard Copy and an electronic version must be provided for the client to use for other non-online training programs.

F. Data Capture:

1. The supplier will spend a total of 6 days, broken up into 2 (two) trips to the facility. During these visits the supplier's staff will capture digital images and video for the courseware. During 1 of the trips the provider will review some of the courseware developed with the training liaison, an operation supervisor and a maintenance supervisor to demonstrate the review process that will be conducted in house by the Owner.

PART 2: PRODUCTS (NOT USED)

PART 3: EXECUTION

3.01 SUBMITTAL SCHEDULE

A. Operation and maintenance manuals shall be delivered directly to the office of the Engineer, as follows:

1. Three preliminary copies of manuals shall be submitted to the office of the Engineer, no later than 30 days following approval of the respective shop drawings.

2. Provide six final copies of complete manuals prior to testing and start-up.

B. The Engineer will review Operation and Maintenance manuals submittals on operating equipment for conformance with the requirements of the applicable specification Section. The review will generally be based on the *O&M Manual Review Checklist* appended to this Section.

C. If during test and start-up of equipment, any changes were made to the equipment, provide copies (the number specified in paragraph 3.01.A.2) of as-built drawings or any other amendments for insertion in the final manuals. Submit the required number within 30 days of start-up and testing of the facility.

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3.02 VENDOR TRAINING/INSTRUCTIONS (TO OWNER's PERSONNEL)

A. Before final initiation of operation, Contractor's vendors shall train/instruct Owner's designated personnel in the operation, adjustment, and maintenance of products, equipment and systems at times convenient to the Owner.

B. Unless specified otherwise under the respective equipment specification section, vendor training/instruction shall consist of eight hours of training for each type of equipment. Such training/instruction shall be scheduled and held at times to accommodate the work schedules of Owner's personnel, including splitting the required training/instruction time into separate sessions and/or presented at reasonable times other than the Contractor's "normal working hours" or the Owner's normal day shift.

C. Use operation and maintenance manuals as basis for instruction. Train/instruct the Owner's personnel, in detail, based on the contents of manual explaining all aspects of operation and maintenance of the equipment. If the respective equipment is inter-related to the operation of other equipment, all interlock, constraints, and permissives shall be explained.

D. At least two weeks prior to the schedule for vendor training, a detailed lesson plan, representative of the material to be covered during instruction, shall be submitted to the Engineer for approval. Lesson plans shall consist of in-depth outlines of the training material, including a table of contents, resume of the instructor, materials to be covered, start-up procedures, maintenance requirements, safety considerations, and shut-down procedures.

E. Prepare and insert additional data in each Operation and Maintenance Manual when the need for such data becomes apparent during training/instruction.

F. Vendor's training/instruction will be considered acceptable based on the completed *Owner's Acknowledgement of Manufacturer's Instruction* as indicated on the Equipment Manufacturer's Certification of Installation, Testing, and Instruction appended to this Section.

END OF SECTION

EQUIPMENT MANUFACTURER'S CERTIFICATE OF INSTALLATION, TESTING AND INSTRUCTION

Owner: _____

Project: _____

Contract No. _____

CDM Smith Project No. _____

EQUIPMENT SPECIFICATION SECTION _____

EQUIPMENT DESCRIPTION _____

I _____, Authorized representative of
(Print Name)

_____
(Print Manufacturer's Name)

hereby CERTIFY that _____
(Print equipment name and model with serial No.)

installed for the subject project [has] [have] been installed in a satisfactory manner, [has] [have] been satisfactorily tested, [is] [are] ready for operation, and that Owner assigned operating personnel have been suitably instructed in the operation, lubrication, and care of the unit[s] on Date: _____ Time: _____.

CERTIFIED BY: _____ DATE: _____
(Signature of Manufacturer's Representative)

OWNER'S ACKNOWLEDGMENT OF MANUFACTURER'S INSTRUCTION

[I] [We] the undersigned, authorized representatives of the _____ and/or Plant Operating Personnel have received classroom and hands on instruction on the operation, lubrication, and maintenance of the subject equipment and [am] [are] prepared to assume normal operational responsibility for the equipment:

_____ DATE: _____

_____ DATE: _____

_____ DATE: _____

## O&M Manual Review Checklist

Submittal No.: _____

Project No.: _____

Manufacturer: _____

Equipment Submitted: _____

Specification Section: _____

Date of Submittal: _____

**General Data**

_____ 1. Are the area representative's name, address, e-mail address and telephone number included?

_____ 2. Is the nameplate data for each component included?

_____ 3. Are all associated components related to the specific equipment included?

_____ 4. Is non-pertinent data crossed out or deleted?

_____ 5. Are drawings neatly folded and/or inserted into packets?

**Operations and Maintenance Data**

_____ 6. Is an overview description of the equipment and/or process included?

_____ 7. Does the description include the practical theory of operation?

_____ 8. Does each equipment component include specific details (design characteristics, operating parameters, control descriptions, and selector switch positions and functions)?

_____ 9. Are alarm and shutdown conditions clearly identified? Does it describe possible causes and recommended remedies?

_____ 10. Are step procedures for starting, stopping, and troubleshooting the equipment included?

_____ 11. Is a list of operational parameters to monitor and record for specific equipment included?

_____ 12. Is a proposed operating log sheet included?

_____ 13. Is a spare parts inventory list included for each component?

_____ 14. Is a lubrication schedule for each component included - or does it clearly state "No Lubrication Required"?

_____ 15. Is a maintenance schedule for each component included?

_____ 16. Is a copy of the warranty information included?

**Review Comments**

Is the submittal fully approved (yes/no)?

If not, see the following are the points of rejection that must be addressed and require resubmittal by the Contractor:

Item No.

1. _____
2. _____
3. _____
4. _____
5. _____
6. _____
7. _____
8. _____
9. _____
10. _____
11. _____
12. _____
13. _____
14, _____
15. _____

Reviewed By: _____ Date: _____

Legend

1 = OK

2 = Not Adequate

3 = Not Included

Note: This submittal has been reviewed for compliance with the Contract Documents.

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SECTION 01740

# WARRANTIES AND BONDS

## PART 1: GENERAL

### 1.01 SCOPE OF WORK

A. This Section specifies general administrative and procedural requirements for warranties and bonds required by the Contract Documents, including manufacturer's standard warranties on products and special warranties.

B. For all major pieces of equipment, submit a warranty from the equipment manufacturer. The manufacturer's warranty period shall be concurrent with the Contractor's for one (1) year, unless otherwise specified, commencing on the date established and accepted by the Owner as substantial completion.

C. The Contractor shall be responsible for obtaining certificates for equipment warranty for all major equipment specified under Divisions 2 through 16. The Engineer reserves the right to request warranties for equipment not classified as major. The Contractor shall still warrant all materials and equipment in the Contractor's one-year warranty period even though certificates of warranty may not be specifically required.

D. In the event that the equipment manufacturer or supplier is unwilling to provide a one-year warranty commencing at the time of Owner acceptance, the Contractor shall obtain from the manufacturer a two (2) year warranty commencing at the time of equipment delivery to the job site. This two-year warranty from the manufacturer shall not relieve the Contractor of the one-year warranty starting at the Owner accepted date of substantial completion. Equipment not in operation at or accepted for operation at the date of substantial completion shall have a warranty from the date of final acceptance by the Owner.

E. The Contractor shall supply a warranty for the installation of all equipment to be relocated. The warranty period shall be one-year from the date of relocation of the equipment.

### 1.02 RELATED WORK

A. Section 00700 – General Conditions. Refer to general requirements relating to warranties and bonds.

B. Section 01700 – Contract Closeout: Refer to closeout requirements.

C. Division 2 through 15: Refer to specific requirements for warranties for the work, products and installations that are specified to be warranted.

D. Certifications and other commitments and agreements for continuing services to Owner are specified elsewhere in the Contract Documents.

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1.03 DEFINITIONS

A. Standard Product Warranties: Preprinted written warranties published by individual manufacturers for particular products that are specifically endorsed by the manufacturer to the Owner.

B. Special Warranties: Written warranties required by or incorporated in the Contract Documents, either to extend time limits provided by standard warranties or to provide greater rights for the Owner.

1.04 SUBMITTALS

A. Submit written warranties to the Owner prior to the date fixed by the Engineer for Substantial Completion. If the 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 the Owner.

B. When a designated portion of the Work is completed and occupied or used by the Owner, by separate agreement with the Contractor during the construction period, submit properly executed warranties to the Owner within fifteen (15) days of completion of that designated portion of the Work.

C. When a special warranty is required to be executed by the Contractor, or the 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 the Owner for approval prior to final execution.

D. Refer to individual Sections of Divisions 2 through 15 for specific content requirements, and particular requirements for submittal of special warranties.

E. At Final Completion, compile two (2) copies of each required warranty and bond properly executed by the Contractor, or by the Contractor, subcontractor, supplier, or manufacturer. Organize the warranty documents into an orderly sequence based on the table of contents of the Project Manual.

F. Bind warranties and bonds in heavy-duty, commercial quality, durable 3-ring clear plastic covered loose-leaf binders, thickness as necessary to accommodate contents and sized to receive 8½-in. by 11-in. paper.

G. Cover: Identify each binder with typed or printed title "WARRANTIES AND BONDS." List the Title of the project and names of the Owner, Contractor and Engineer.

H. Table of Contents: Neatly typed, in the sequence of the Table of Contents of the Project Manual, with each item identified with the number and title of the Section in which specified and the name of the product or work item.

I. Provide heavy paper dividers with celluloid covered tabs for each separate warranty. Mark the tab to identify the product or installation. Provide a typed description of the product or installation, including the name of the product and the name, address and telephone number of the installer, supplier and manufacturer.

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J. When operating and maintenance manuals are required for warranted construction, provide additional copies of each required warranty, as necessary, for inclusion in each required manual.

PART 2: PRODUCTS (NOT USED)

PART 3: EXECUTION

3.01 WARRANTY REQUIREMENTS

A. 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.

B. 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.

C. 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. The Contractor is responsible for the cost of replacing or rebuilding defective work regardless of whether the Owner has benefited from use of the work through a portion of its anticipated useful service life.

D. Owner's Recourse: Written warranties made to the 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 the Owner can enforce such other duties, obligations, rights, or remedies.

E. Rejection of Warranties: The Owner reserves the right to reject warranties and to limit selections to products with warranties not in conflict with requirements of the contract Documents.

F. The 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.

G. Disclaimers and Limitations: Manufacturer's disclaimers and limitations on product warranties do not relieve the 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 the Contractor.

H. Separate Prime Contracts: Each Prime Contractor is responsible for warranties related to its own Contract.

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3.02 MANUFACTURERS CERTIFICATIONS

A. Where required, the Contractor shall supply evidence, satisfactory to the Engineer, that the Contractor can obtain manufacturers' certifications as to the Contractor's installation of equipment.

END OF SECTION

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SECTION 01741

# CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL

## PART 1: GENERAL

### 1.01 SCOPE OF WORK

A. Furnish all labor, materials, equipment and incidentals required and design and deliver construction waste management and disposal for the Project as shown on the Drawings and as specified herein.

B. The work includes administrative and procedural requirements for the following:

1. Salvaging nonhazardous demolition and construction waste.

2. Recycling nonhazardous demolition and construction waste.

3. Disposing of nonhazardous demolition and construction waste.

### 1.02 RELATED WORK

A. Disposition of waste resulting from demolition of buildings, structures, and site improvements, and for disposition of hazardous waste is included in Division 2.

B. Disposition of waste resulting from partial demolition of buildings, structures, and site improvements, and for disposition of hazardous waste is included in Division 2.

C. Disposition of waste resulting from site clearing and removal of above- and below-grade improvements is included in Division 2.

### 1.03 SUBMITTALS

A. Submit in accordance with Section 01300.

B. Waste Management Plan: Submit plan within 30 days of date established for the Notice to Proceed.

C. Waste Reduction Progress Reports: Concurrent with each Application for Payment, submit report. Use CWM-7 for construction waste and Form CWM-8 for demolition waste. Include the following information:

1. Material category.

2. Generation point of waste.

3. Total quantity of waste in tons (tonnes).

4. Quantity of waste salvaged, both estimated and actual in tons (tonnes).

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5. Quantity of waste recycled, both estimated and actual in tons (tonnes).

6. Total quantity of waste recovered (salvaged plus recycled) in tons (tonnes).

7. Total quantity of waste recovered (salvaged plus recycled) as a percentage of total waste.

D. Waste Reduction Calculations: Before request for Substantial Completion, submit calculated end-of-Project rates for salvage, recycling, and disposal as a percentage of total waste generated by the Work.

E. Records of Donations: Indicate receipt and acceptance of salvageable waste donated to individuals and organizations. Indicate whether organization is tax exempt.

F. Records of Sales: Indicate receipt and acceptance of salvageable waste sold to individuals and organizations. Indicate whether organization is tax exempt.

G. Recycling and Processing Facility Records: Indicate receipt and acceptance of recyclable waste by recycling and processing facilities licensed to accept them. Include manifests, weight tickets, receipts, and invoices.

H. Landfill and Incinerator Disposal Records: Indicate receipt and acceptance of waste by landfills and incinerator facilities licensed to accept them. Include manifests, weight tickets, receipts, and invoices.

1.04 REFERENCE STANDARDS

A. ASTM International

1. ASTM E 1609 - Development and Implementation of a Pollution Prevention Program

B. Where reference is made to one of the above or other referenced standards, the revisions in effect at the time of bid opening shall apply.

1.05 DEFINITIONS

A. Construction Waste: Building and site improvement materials and other solid waste resulting from construction, remodeling, renovation, or repair operations. Construction waste includes packaging.

B. Demolition Waste: Building and site improvement materials resulting from demolition or selective demolition operations.

C. Disposal: Removal off-site of demolition and construction waste and subsequent sale, recycling, reuse, or deposit in landfill or incinerator acceptable to authorities having jurisdiction.

D. Recycle: Recovery of demolition or construction waste for subsequent processing in preparation for reuse.

E. Salvage: Recovery of demolition or construction waste and subsequent sale or reuse in another facility.

F. Salvage and Reuse: Recovery of demolition or construction waste and subsequent incorporation into the Work.

1.06 PERFORMANCE REQUIREMENTS

A. General: Achieve end-of-Project rates for salvage/recycling of 50 percent by weight of total non-hazardous solid waste generated by the Work. Practice efficient waste management in the use of materials in the course of the Work. Use all reasonable means to divert construction and demolition waste from landfills and incinerators. Facilitate recycling and salvage of materials including the following:

1. Demolition Waste:

a. Asphalt paving.

b. Concrete.

c. Concrete reinforcing steel.

d. Brick.

e. Concrete masonry units.

f. Wood studs.

g. Wood joists.

h. Plywood and oriented strand board.

i. Wood paneling.

j. Wood trim.

k. Structural and miscellaneous steel.

l. Rough hardware.

m. Roofing.

n. Insulation.

o. Doors and frames.

p. Door hardware.

q. Windows.

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r. Glazing.

s. Metal studs.

t. Gypsum board.

u. Acoustical tile and panels.

v. Carpet.

w. Carpet pad.

x. Demountable partitions.

y. Equipment.

z. Cabinets.

aa. Plumbing fixtures.

bb. Piping.

cc. Supports and hangers.

dd. Valves.

ee. Sprinklers.

ff. Mechanical equipment.

gg. Refrigerants.

hh. Electrical conduit.

ii. Copper wiring.

jj. Lighting fixtures.

kk. Lamps.

ll. Ballasts.

mm. Electrical devices.

nn. Switchgear and panelboards.

oo. Transformers.

2. Construction Waste:

   a. Masonry and CMU.

   b. Lumber.

   c. Wood sheet materials.

   d. Wood trim.

   e. Metals.

   f. Roofing.

   g. Insulation.

   h. Carpet and pad.

   i. Gypsum board.

   j. Piping.

   k. Electrical conduit.

   l. Packaging: Regardless of salvage/recycle goal indicated in "General" Paragraph above, salvage or recycle 100 percent of the following uncontaminated packaging materials:

      1) Paper.

      2) Cardboard.

      3) Boxes.

      4) Plastic sheet and film.

      5) Polystyrene packaging.

      6) Wood crates.

      7) Plastic pails.

1.07 QUALITY ASSURANCE

A. Waste Management Coordinator Qualifications: Experienced firm, with a record of successful waste management coordination of projects with similar requirements.

B. Refrigerant Recovery Technician Qualifications: Certified by EPA-approved certification program.

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C. Regulatory Requirements: Comply with hauling and disposal regulations of authorities having jurisdiction.

D. Waste Management Conference: Conduct conference at Project site. Review methods and procedures related to waste management including, but not limited to, the following:

1. Review and discuss waste management plan including responsibilities of waste management coordinator.

2. Review requirements for documenting quantities of each type of waste and its disposition.

3. Review and finalize procedures for materials separation and verify availability of containers and bins needed to avoid delays.

4. Review procedures for periodic waste collection and transportation to recycling and disposal facilities.

5. Review waste management requirements for each trade.

1.08 WASTE MANAGEMENT PLAN

A. General: Develop a waste management plan according to ASTM E 1609 and requirements in this Section. Plan shall consist of waste identification, waste reduction work plan, and cost/revenue analysis. Distinguish between demolition and construction waste. Indicate quantities by weight or volume, but use same units of measure throughout waste management plan.

B. Waste Identification: Indicate anticipated types and quantities of demolition, site-clearing and construction waste generated by the Work. Use Form CWM-1 for construction waste and Form CWM-2 for demolition waste. Include estimated quantities and assumptions for estimates.

C. Waste Reduction Work Plan: List each type of waste and whether it will be salvaged, recycled, or disposed of in landfill or incinerator. Use Form CWM-1 for construction waste and Form CWM-2 for demolition waste. Include points of waste generation, total quantity of each type of waste, quantity for each means of recovery, and handling and transportation procedures.

1. Salvaged Materials for Reuse: For materials that will be salvaged and reused in this Project, describe methods for preparing salvaged materials before incorporation into the Work.

2. Salvaged Materials for Sale: For materials that will be sold to individuals and organizations, include list of their names, addresses, and telephone numbers.

3. Salvaged Materials for Donation: For materials that will be donated to individuals and organizations, include list of their names, addresses, and telephone numbers.

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4. Recycled Materials: Include list of local receivers and processors and type of recycled materials each will accept. Include names, addresses, and telephone numbers.

5. Disposed Materials: Indicate how and where materials will be disposed of. Include name, address, and telephone number of each landfill and incinerator facility.

6. Handling and Transportation Procedures: Include method that will be used for separating recyclable waste including sizes of containers, container labeling, and designated location where materials separation will be performed.

D. Cost/Revenue Analysis: Indicate total cost of waste disposal as if there was no waste management plan and net additional cost or net savings resulting from implementing waste management plan. Use Form CWM-1 for construction waste and Form CWM-2 for demolition waste. Include the following:

1. Total quantity of waste.

2. Estimated cost of disposal (cost per unit). Include hauling and tipping fees and cost of collection containers for each type of waste.

3. Total cost of disposal (with no waste management).

4. Revenue from salvaged materials.

5. Revenue from recycled materials.

6. Savings in hauling and tipping fees by donating materials.

7. Savings in hauling and tipping fees that are avoided.

8. Handling and transportation costs. Include cost of collection containers for each type of waste.

9. Net additional cost or net savings from waste management plan.

PART 2: PRODUCTS (NOT USED)

PART 3: EXECUTION

3.01 PLAN IMPLEMENTATION

A. General: Implement approved waste management plan. Provide handling, containers, storage, signage, transportation, and other items as required to implement waste management plan during the entire duration of the Contract.

1. Comply with operation, termination, and removal requirements in Section 01500.

B. Waste Management Coordinator: Engage a waste management coordinator to be responsible for implementing, monitoring, and reporting status of waste management work plan.

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C. Training: Train workers, subcontractors, and suppliers on proper waste management procedures, as appropriate for the Work.

1. Distribute waste management plan to everyone concerned within seven days of submittal return.

2. Distribute waste management plan to entities when they first begin work on-site. Review plan procedures and locations established for salvage, recycling, and disposal.

D. Site Access and Temporary Controls: Conduct waste management operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.

1. Designate and label specific areas on Project site necessary for separating materials that are to be salvaged, recycled, reused, donated, and sold.

2. Comply with Section 01500 for controlling dust and dirt, environmental protection, and noise control.

3.02 SALVAGING DEMOLITION WASTE

A. Salvaged Items for Reuse in the Work: Salvage items for reuse and handle as follows:

1. Clean salvaged items.

2. Pack or crate items after cleaning. Identify contents of containers with label indicating elements, date of removal, quantity, and location where removed.

3. Store items in a secure area until installation.

4. Protect items from damage during transport and storage.

5. Install salvaged items to comply with installation requirements for new materials and equipment. Provide connections, supports, and miscellaneous materials necessary to make items functional for use indicated.

B. Salvaged Items for Owner's Use: Salvage items for Owner's use and handle as follows:

1. Clean salvaged items.

2. Pack or crate items after cleaning. Identify contents of containers with label indicating elements, date of removal, quantity, and location where removed.

3. Store items in a secure area until delivery to Owner.

4. Transport items to Owner's storage area [on-site] [off-site] [designated by Owner].

5. Protect items from damage during transport and storage.

C. Doors and Hardware: Brace open end of door frames. Except for removing door closers, leave door hardware attached to doors.

D. Equipment: Drain tanks, piping, and fixtures. Seal openings with caps or plugs. Protect equipment from exposure to weather.

E. Plumbing Fixtures: Separate by type and size.

F. Lighting Fixtures: Separate lamps by type and protect from breakage.

G. Electrical Devices: Separate switches, receptacles, switchgear, transformers, meters, panelboards, circuit breakers, and other devices by type.

3.03 RECYCLING DEMOLITION AND CONSTRUCTION WASTE, GENERAL

A. General: Recycle paper and beverage containers used by on-site workers.

B. Recycling Receivers and Processors: List below is provided for information only; available recycling receivers and processors include, but are not limited to, the following:

1. <Insert names and telephone numbers of local recycling receivers and processors of recyclable materials>.

C. Recycling Incentives: Revenues, savings, rebates, tax credits, and other incentives received for recycling waste materials shall be shared equally by Owner and Contractor.

D. Preparation of Waste: Prepare and maintain recyclable waste materials according to recycling or reuse facility requirements. Maintain materials free of dirt, adhesives, solvents, petroleum contamination, and other substances deleterious to the recycling process.

E. Procedures: Separate recyclable waste from other waste materials, trash, and debris. Separate recyclable waste by type at Project site to the maximum extent practical according to approved construction waste management plan.

1. Provide appropriately marked containers or bins for controlling recyclable waste until removed from Project site. Include list of acceptable and unacceptable materials at each container and bin.

a. Inspect containers and bins for contamination and remove contaminated materials if found.

2. Stockpile processed materials on-site without intermixing with other materials. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.

3. Stockpile materials away from construction area. Do not store within drip line of remaining trees.

4. Store components off the ground and protect from the weather.

5. Remove recyclable waste from Owner's property and transport to recycling receiver or processor.

3.04 RECYCLING DEMOLITION WASTE

A. Asphalt Paving: Grind asphalt to maximum [1-1/2-inch (38-mm)] [4-inch (100-mm)] size.

1. Crush asphaltic concrete paving and screen to comply with requirements in Section (31 20 00) (02XXX) for use as general fill.

B. Asphalt Paving: Break up and transport paving to asphalt-recycling facility.

C. Concrete: Remove reinforcement and other metals from concrete and sort with other metals.

1. Pulverize concrete to maximum [1-1/2-inch (38-mm)] [4-inch (100-mm)] size.

2. Crush concrete and screen to comply with requirements in Section (31 20 00) (02XXX) for use as satisfactory soil for fill or subbase.

D. Masonry: Remove metal reinforcement, anchors, and ties from masonry and sort with other metals.

1. Pulverize masonry to maximum [3/4-inch (19-mm)] [1-inch (25-mm)] [1-1/2-inch (38-mm)] [4-inch (100-mm)] size.

a. Crush masonry and screen to comply with requirements in Section 312000 "Earth Moving" for use as [general fill] [satisfactory soil for fill or subbase].

b. Crush masonry and screen to comply with requirements in Section (32 93 00) (02XXX) for use as mineral mulch.

2. Clean and stack undamaged, whole masonry units on wood pallets.

E. Wood Materials: Sort and stack members according to size, type, and length. Separate lumber, engineered wood products, panel products, and treated wood materials.

F. Metals: Separate metals by type.

1. Structural Steel: Stack members according to size, type of member, and length.

2. Remove and dispose of bolts, nuts, washers, and other rough hardware.

G. Asphalt Shingle Roofing: Separate organic and glass-fiber asphalt shingles and felts. Remove and dispose of nails, staples, and accessories.

H. Gypsum Board: Stack large clean pieces on wood pallets or in container and store in a dry location. Remove edge trim and sort with other metals. Remove and dispose of fasteners.

I. Acoustical Ceiling Panels and Tile: Stack large clean pieces on wood pallets and store in a dry location.

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J. Metal Suspension System: Separate metal members including trim, and other metals from acoustical panels and tile and sort with other metals.

K. Carpet: Roll large pieces tightly after removing debris, trash, adhesive, and tack strips.

1. Store clean, dry carpet in a closed container or trailer provided by Carpet Reclamation Agency or carpet recycler.

L. Carpet Tile: Remove debris, trash, and adhesive.

1. Stack tile on pallet and store clean, dry carpet in a closed container or trailer provided by Carpet Reclamation Agency or carpet recycler.

M. Piping: Reduce piping to straight lengths and store by type and size. Separate supports, hangers, valves, sprinklers, and other components by type and size.

N. Conduit: Reduce conduit to straight lengths and store by type and size.

3.05 RECYCLING CONSTRUCTION WASTE

A. Packaging:

1. Cardboard and Boxes: Break down packaging into flat sheets. Bundle and store in a dry location.

2. Polystyrene Packaging: Separate and bag materials.

3. Pallets: As much as possible, require deliveries using pallets to remove pallets from Project site. For pallets that remain on-site, break down pallets into component wood pieces and comply with requirements for recycling wood.

4. Crates: Break down crates into component wood pieces and comply with requirements for recycling wood.

B. Wood Materials:

1. Clean Cut-Offs of Lumber: Grind or chip into small pieces.

2. Clean Sawdust: Bag sawdust that does not contain painted or treated wood.

a. Comply with requirements in Division (2) (32) for use of clean sawdust as organic mulch.

C. Gypsum Board: Stack large clean pieces on wood pallets or in container and store in a dry location.

1. Clean Gypsum Board: Grind scraps of clean gypsum board using small mobile chipper or hammer mill. Screen out paper after grinding.

a. Comply with requirements in Division (2) (32) for use of clean ground gypsum board as inorganic soil amendment.

3.06 DISPOSAL OF WASTE

A. General: Except for items or materials to be salvaged, recycled, or otherwise reused, remove waste materials from Project site and legally dispose of them in a landfill or incinerator acceptable to authorities having jurisdiction.

1. Except as otherwise specified, do not allow waste materials that are to be disposed of accumulate on-site.

2. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.

B. Burning: Do not burn waste materials.

C. Burning: Burning of waste materials is permitted only at designated areas on Owner's property, provided required permits are obtained. Provide full-time monitoring for burning materials until fires are extinguished.

D. Disposal: Remove waste materials and dispose of at designated spoil areas on Owner's property.

E. Disposal: Remove waste materials from Owner's property and legally dispose of them.

3.07 ATTACHMENTS

A. Form CWM-1 for construction waste identification.

B. Form CWM-2 for demolition waste identification.

END OF SECTION

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| FORM CWM-1: CONSTRUCTION WASTE IDENTIFICATION | | | | | | | |
|---|---|---|---|---|---|---|---|
| MATERIAL CATEGORY | GENERATION POINT | EST. QUANTITY OF MATERIALS RECEIVED* (A) | EST. WASTE - % (B) | TOTAL EST. QUANTITY OF WASTE* (C = A x B) | EST. VOLUME CY (C14) | EST. WEIGHT TONS (TONNES) | REMARKS AND ASSUMPTIONS |
| Packaging: Cardboard | | | | | | | |
| Packaging: Boxes | | | | | | | |
| Packaging: Plastic Sheet or Film | | | | | | | |
| Packaging: Polystyrene | | | | | | | |
| Packaging: Pallets or Skids | | | | | | | |
| Packaging: Crates | | | | | | | |
| Packaging: Paint Cans | | | | | | | |
| Packaging: Plastic Pails | | | | | | | |
| Site-Clearing Waste | | | | | | | |
| Masonry or CMU | | | | | | | |
| Lumber: Cut-Offs | | | | | | | |
| Lumber: Warped Pieces | | | | | | | |
| Plywood or OSB (scraps) | | | | | | | |
| Wood Forms | | | | | | | |
| Wood Waste Chutes | | | | | | | |
| Wood Trim (cut-offs) | | | | | | | |
| Metals | | | | | | | |
| Insulation | | | | | | | |
| Roofing | | | | | | | |
| Joint Sealant Tubes | | | | | | | |
| Gypsum Board (scraps) | | | | | | | |
| Carpet and Pad (scraps) | | | | | | | |
| Piping | | | | | | | |
| Electrical Conduit | | | | | | | |
| Other: | | | | | | | |

* Insert units of measure.

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| FORM CWM-2: DEMOLITION WASTE IDENTIFICATION | | | | |
|---|---|---|---|---|
| MATERIAL DESCRIPTION | EST. QUANTITY | EST. VOLUME CY (CM) | EST. WEIGHT TONS (TONNES) | REMARKS AND ASSUMPTIONS |
| Asphaltic Concrete Paving | | | | |
| Concrete | | | | |
| Brick | | | | |
| CMU | | | | |
| Lumber | | | | |
| Plywood and OSB | | | | |
| Wood Paneling | | | | |
| Wood Trim | | | | |
| Miscellaneous Metals | | | | |
| Structural Steel | | | | |
| Rough Hardware | | | | |
| Insulation | | | | |
| Roofing | | | | |
| Doors and Frames | | | | |
| Door Hardware | | | | |
| Windows | | | | |
| Glazing | | | | |
| Acoustical Tile | | | | |
| Carpet | | | | |
| Carpet Pad | | | | |
| Demountable Partitions | | | | |
| Equipment | | | | |
| Cabinets | | | | |
| Plumbing Fixtures | | | | |
| Piping | | | | |
| Piping Supports and Hangers | | | | |
| Valves | | | | |
| Sprinklers | | | | |
| Mechanical Equipment | | | | |
| Electrical Conduit | | | | |
| Copper Wiring | | | | |
| Light Fixtures | | | | |
| Lamps | | | | |
| Lighting Ballasts | | | | |
| Electrical Devices | | | | |
| Switchgear and Panelboards | | | | |
| Transformers | | | | |
| Other: | | | | |

# *DIVISION 2*

# *SITE WORK*

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SECTION 02050

# DEMOLITION AND MODIFICATIONS

## PART 1: GENERAL

### 1.01 SCOPE OF WORK

A. Furnish all labor, materials, equipment and incidentals required; and demolish, modify, remove and dispose of work shown on the Drawings and as specified herein.

B. The work shall include demolition, modification, and removal of existing materials; and furnishing equipment or work necessary to install the new work, and to connect with existing work in an approved manner.

C. Demolition, modifications, and removals specified under other Sections of these Specifications shall conform to requirements of this Section.

D. Demolition and Modifications include:

1. Work related to the Existing Clarifier Structure

2. Site demolition work including concrete pads, asphalt paving, piping, sanitary sewer manholes, drainage structures, etc. as indicated on the Drawings.

3. Other demolition and modifications as indicated on the Drawings.

E. Building demolition work includes all building contents, foundations and structures, equipment, piping, valves, miscellaneous metals, electrical switchgear, and other ancillary items and materials as shown on the Drawings.

F. Dispose of all demolished materials and other debris off-site. Construction rubble, including concrete and masonry, may be disposed of on-site in specific areas designated by the Engineer.

G. Blasting and the use of explosives will not be permitted for any demolition work.

### 1.02 RELATED WORK

A. Section 01300 – Submittals.

B. Section 01445 – Testing and Cleaning of Pipelines.

C. Section 01562 – Dust Control.

D. Section 02100 – Site Preparation.

E. Section 02220 – Excavation, Trenching and Backfilling (Structural).

F. Section 02221 – Excavation, Trenching and Backfilling (Piping).

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1.03 SUBMITTALS

A. See Section 01300 – Submittals, for submittal procedures.

B. Submit proposed methods and operations of demolition and modifications of structures prior to the start of work. Include a schedule of shutoff, capping, and/or continuation of utility services as required.

C. Furnish a detailed sequence of demolition and removal work to ensure the uninterrupted progress of the Owner's operations. Demolition and removal sequence shall be compatible with sequence of construction and shutdown coordination requirements.

1.04 SCHEDULING

A. At least 48 hours prior to commencing demolition or removal, notify the Engineer in writing of the proposed schedule. The Owner shall inspect any affected existing equipment and identify those items that are to remain the property of the Owner. No removals shall start without authorization from the Engineer.

B. Before commencing demolition work, complete all modifications necessary to bypass the affected structure. Actual work shall not begin until the Owner and Engineer have inspected and approved the modifications, and authorized commencement of the demolition work.

C. Carry out operations so as to avoid interference with operations and work in existing facilities.

1.05 PROJECT/SITE CONDITIONS

A. The Owner and the Engineer assume no responsibility for the actual condition of the structures to be demolished or modified.

B. Conditions existing at the time of inspection for bidding purposes will be maintained by the Owner insofar as practical. However, variations within a structure may occur prior to the start of demolition work.

1.06 RULES AND REGULATIONS

A. The Building Code of the City of Russellville, AR shall control the demolition, modification or alteration of the existing buildings or structures.

B. No building or structure, or any part thereof, shall be demolished until an application has been filed with the Building Inspector and a permit issued.

C. The Contractor is responsible for the demolition permit application and any applicable permit fees.

1.07 DISPOSAL OF MATERIALS

A. Unless otherwise noted, salvageable material and equipment listed in this specification remain the property of the Owner. Dismantle all such materials to a size that can be readily handled and deliver them to a designated storage area.

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B. Any salvaged material damaged due to improper handling will not be accepted and the replacement value of the material deducted from the payment to the Contractor.

C. All other materials and items of equipment shall become the Contractor's property and must be removed from the site.

D. The storage or sale of removed items on the site is not allowed.

PART 2: PRODUCTS (NOT USED)

PART 3: EXECUTION

3.01 GENERAL

A. The Owner retains the right of refusal for all materials and equipment removed from the existing work. All materials and equipment removed from existing work become the property of the Contractor, except for those items that the Owner has identified and marked to retain. Carefully remove so as not to damage all materials and equipment marked by the Owner to remain. Clean, store and protect on-site or at a location adjacent to the site as directed by the Owner.

B. Dispose of all demolition materials, equipment, debris and all other items not marked by the Owner to remain. Unless otherwise indicated on the Drawings, dispose of items off-site and in conformance with all existing applicable laws and regulations.

3.02 PROTECTION

A. Traffic Access

1. Conduct demolition and modification operations and the removal of equipment and debris to ensure minimum interference with roads, streets, walks, both on-site and off-site. Ensure minimum interference with occupied or used facilities.

2. Direct special attention towards maintaining safe and convenient access to existing facilities by plant personnel and plant associated vehicles.

3. Do not close or obstruct streets, walks or other occupied or used facilities without authorization from the Engineer. Furnish alternate routes around closed or obstructed traffic in access ways.

B. Closing or obstructing roadways, sidewalks and passageways adjacent to the work by the placement or storage of materials will not be permitted. Conduct all operations with a minimum interference to traffic on these ways.

C. Erect and maintain barriers, lights, and other required protection devices.

D. Pollution Control

1. Use water sprinkling, temporary enclosures, or other suitable methods to limit the amount of dust and dirt to the lowest practical level. Comply with governing regulations pertaining to environmental protection.

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2. Do not use water when it may create hazardous or objectionable conditions such as pollution, flooding or ice.

3.03 STRUCTURAL REMOVAL

A. Remove structures to the lines and grades shown on the Drawings, unless otherwise directed by the Engineer. The removal of masonry beyond these limits shall be at the Contractor's expense. Excess removals shall be reconstructed to the satisfaction of the Engineer and at no additional cost to the Owner.

B. Unless otherwise noted on the Drawings, demolish and remove from the site all tile, reinforcement, structural or miscellaneous metals, plaster, wire mesh, and other items contained in or upon the structure. Do not use demolished items for structural or trench backfill material.

C. After removal of parts or all of masonry walls, slabs and like work that ties into new or existing work, neatly repair the junction point so as to leave only finished edges and surfaces exposed.

D. Unless otherwise indicated on the Drawings, demolish concrete structures to a point 24-in. below finished grade. Flood below grade tanks, vaults, etc. with sand and install an earthen cap of compacted select material.

E. For the installation of new structures or equipment, and where the Drawings do not indicate demolition limits, remove the existing structure to a point 4-in. outside the footprint of the item proposed for installation.

3.04 MECHANICAL REMOVAL

A. Mechanical removals shall consist of dismantling and removing buried and exposed piping, and other appurtenances as specified, shown on the Drawings, or required for the completion of the Work. Removals include cutting, capping and plugging piping as required for complete removal from service. Other Sections of Division 2 include specifications for cutting existing piping for the purpose of making connections.

B. Remove existing process, water and other piping not required for the new work as shown on the Drawings, or where it will interfere with new work. Unless otherwise shown on the Drawings, remove piping to the nearest solid support, cap the piping, and leave the remainder in place.

C. When underground piping is altered or removed, cap the remaining pipe and block as necessary. Underground piping may be abandoned in place if noted on the Drawings, and if it does not interfere with new work.

D. Changes to potable water piping and other plumbing and heating system work shall conform to all applicable codes and requirements as new piping construction. Pressure test and disinfect all altered or opened portions of the potable water system in accordance with other Sections of these Specifications. Pressure test all other plumbing and heating piping.

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E. Remove existing pumps, motors, equipment and other appurtenances as shown on the Drawings, or as required for the completion of the Work.

3.05 ELECTRICAL REMOVAL

A. Remove existing transformers, distribution switchboards, control panels and panel boards, motors, conduits and wires, poles and overhead wiring, lighting fixtures and miscellaneous electrical equipment as shown on the Drawings, specified herein, or required to perform the work.

B. Remove existing electrical equipment and fixtures with such care as required to prevent unnecessary damage, to keep existing systems in operation, and to maintain the integrity of the grounding systems.

C. Abandon or remove conduits and wiring where shown on the Drawings. Remove, salvage and store all wires in abandoned conduits. Abandon conduits concealed in floor, ceiling slabs, or in walls by cutting flush with the slab or wall at the point of entrance. Close the conduits with a suitable plug and repair the area in a flush, smooth and approved manner. Disassemble and remove exposed conduits and their supports from the site. Repair all areas of work to prevent rust spots on exposed surfaces.

D. Where shown or otherwise required, remove wiring in underground duct systems. Salvage and store all such wiring as specified. Verify the function of all wiring before disconnection and removal. Plug ducts not scheduled for reuse where they enter buildings, and make the penetrations watertight.

E. Where shown on the Drawings, abandon direct-burial cable. Disconnect such cable at both ends of the run. Where it enters a building or structure, cut the cable back to the point of entrance. Patch all opening in buildings at the entrance of abandoned direct-burial cable, and make the penetrations watertight.

F. Where shown on the Drawings, abandon poles and overhead wiring. The power company will remove existing substation and power poles owned by the power company. Remove poles not owned by the power company from the site. Salvage and store the overhead wires. Perform this work after completing and energizing the proposed electric service, and in accordance with the approved schedule.

G. Where shown on the Drawings, remove or relocate lighting fixtures. Remove and dispose of fixtures not scheduled for relocation. Carefully remove relocated fixtures from their present location and rehang where shown.

H. Remove and dispose of wall switches, receptacles, starters and other miscellaneous electrical equipment as required. Exercise care in removing all equipment so as to minimize damage to architectural and structural members. Repair any damage incurred at no additional cost to the Owner.

3.06 REPAIR

A. Promptly repair damage caused to adjacent facilities by demolition operation when directed by the Engineer, and at no additional cost to the Owner. Repair facilities and structures at least equal to that which existed prior to the start of construction.

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3.07 CLEAN-UP

A. Remove from the site all debris resulting from the demolition operations as it accumulates, and dispose of it at an approved disposal site. Upon completion of the work, all materials, equipment, waste and debris of every sort shall be removed and premises shall be left clean, neat and orderly.

B. Clean adjacent structures, facilities and improvements of dust, dirt and debris caused by demolition operations. Return adjacent areas to conditions existing prior to the start of work.

END OF SECTION

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# SECTION 02100

# SITE PREPARATION

## PART 1: GENERAL

### 1.01 SCOPE OF WORK

A. Furnish all labor, materials and equipment and perform all site preparation and removal of obstructions, complete as shown on the Drawings and as specified herein.

B. Areas to be cleared, grubbed and stripped generally consist of areas within the project site where construction is proposed. Additional areas, adjacent to particular construction sites, are specifically designated on the Drawings.

### 1.02 RELATED WORK

A. Section 01011 – Site Conditions.

B. Section 02050 – Demolition and Modifications.

C. Section 02200 – Earthwork.

D. Section 02930 – Seeding for Site Restoration.

### 1.03 COORDINATION

A. Completely coordinate the work of this Section with the work of other sections. Verify at the site both the dimensions and work of other trades adjoining items of work in this section before commencement of items specified herein.

B. Furnish to the pertinent trades all items included under this Section that are to be built into the work of other sections.

### 1.04 FIELD MEASUREMENTS

A. Take field measurements at the site to verify or supplement indicated dimensions and to ensure proper coordination of all other construction items.

### 1.05 LIMITS OF WORK

A. The limits of the work under this contract shall extend to the right-of-way or easement lines unless otherwise indicated on the plans or in 01011 Site Conditions.

B. The Contracting Authority will not be responsible for obtaining additional sites for the storage of equipment, the stockpiling of materials, the securing of additional material, or other lands not required by the finished construction. No separate payment will be made for acquisition or use of off-site storage areas.

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1.06 DEFINITIONS

A. Remove: Remove and legally dispose of items except those indicated to be reinstalled, salvaged, or to remain the Owner's property.

B. Remove and Salvage: Items indicated to be removed and salvaged remain the Owner's property. Remove, clean, and pack or crate items to protect against damage. Identify contents of containers and deliver to Owner's designated storage area.

C. Remove and Reinstall: Remove items indicated; clean, service, and otherwise prepare them for reuse; store and protect against damage. Reinstall items in the same locations or in locations indicated.

D. Remove and Replace: Remove and legally dispose of items and replace with new items as indicated.

E. Existing to Remain: Protect construction indicated to remain against damage. When permitted by the Engineer, remove items to a suitable, protected storage location during construction, and then clean and reinstall items in their original locations.

1.07 SUBMITTALS

A. Submit copies of all required permits prior to clearing, grubbing and stripping work, in accordance with Section 01300.

PART 2: PRODUCTS (NOT USED)

PART 3: EXECUTION

3.01 CLEARING VEGETATION

A. Cut and remove all timber, trees, stumps, brush, shrubs, roots, grass, weeds, rubbish and any other objectionable material resting on or protruding through the surface of the ground.

B. Preserve and protect trees and other vegetation designated on the Drawings or directed to remain by the Engineer to remain as specified below.

3.02 GRUBBING

A. Grub and remove all stumps roots in excess of 1½-in. in diameter, matted roots, brush, timber, logs, concrete rubble, and other debris encountered to a depth of 18 inches below original grade.

B. Refill all grubbing holes and depressions excavated below the finished ground surface with suitable materials and compact to a density conforming to the requirements of Section 02200.

3.03 STRIPPING

A. Strip and stockpile topsoil from all areas to be occupied by buildings, structures, sidewalks, roadways, and all areas to be excavated or filled.

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B. Stockpile topsoil free from brush, trash, large stones, and other extraneous material. Avoid mixing topsoil with subsoil.

C. Protect stockpiled topsoil until it is used for site restoration or landscaping. Dispose of surplus topsoil on site after all work is completed.

3.04 DISPOSAL

A. Dispose of material and debris from site preparation operations by hauling to an approved off-site disposal area. Burial of rubbish or debris is not allowed on the project site.

B. On-site disposal of cleared and grubbed materials by open-air burning may be permitted only with the expressed written consent of the Owner. Burning operations and ash disposal shall be conducted in strict accordance with local and state requirements, subject to applicable permit requirements.

3.05 PROTECTING VEGETATION

A. Protect trees and other vegetation designated on the Drawings or directed by the Engineer to remain from damage by all construction operations by erecting suitable barriers, guards, enclosures or by other approved means. Conduct clearing operations in a manner to prevent falling trees from damaging trees and vegetation designated to remain, to prevent damaging the work being constructed, and to provide for the safety of employees and others.

B. Maintain protection until all work has been completed.

C. Do not operate heavy equipment or stockpile materials within the branch spread (drip line) of existing trees.

D. Secure the services of a certified arborist or approved tree service to immediately repair any damage to existing tree crowns, trunks, or root systems.

E. When work is completed, remove all dead and downed trees. Trim all live trees of dead and diseased limbs and branches. Make all cuts cleanly at their juncture with the branch or proceeding branch without injury to the trunk or remaining branches.

F. Restrict construction activities to those areas within the limits of construction as designated on the Drawings, within public rights-of-way, and within easements provided by the Owner. Restore damage to adjacent public or private properties and improvements to their original condition and to the full satisfaction of the property owner.

3.06 CLEARING OTHER WORK AREA OBSTRUCTIONS

A. Clear the work area of all obstructions that will affect or will be affected by the construction of the project. Remove all items so encountered unless otherwise shown on the plans or otherwise directed by the Engineer. These items shall include, but not be limited to: signs, culverts, headwalls, pavements, landscaping and other items constituting an obstruction, which are encountered.

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B. Remove as part of the clearing operation all structures, foundations, culverts, headwalls, concrete slabs and other obstructions or rubbish of any nature, which interfere with the proposed improvements, unless otherwise directed by the Engineer or noted on the plans.

3.07 PROTECTING AND REMOVING OBSTRUCTIONS

A. Take every precaution in protecting and removing obstructions that are to be replaced or reconstructed.

3.08 OBSTRUCTIONS NOT SHOWN ON PLANS

A. The plans show the location of certain exposed and buried obstructions, as well as existing surface and subsurface structures. Neither the Owner nor the Engineer assumes any responsibility for failure to show obstruction or structures on the plans or to show them in their exact location. The absence of these obstructions on the drawings does not relieve the Contractor of any responsibility in the protection, removal and satisfactory replacement of these obstructions. The failure to show the obstructions will not be considered sufficient basis for claims for extra work or for increasing the pay quantities in any manner whatsoever, unless the obstruction encountered is such as to necessitate substantial changes in the lines and grades of the proposed improvements or requires the building of a special structure.

B. The removal of existing franchised utility mains required to permit orderly progress of the work shall be accomplished by local agencies, as shown on the Drawings or specified within these specifications. Notify all utility companies, all pipeline owners, or other parties affected, and endeavor to have the necessary adjustments of the public or private utility fixtures, pipelines, pole lines, and other appurtenances within or adjacent to the limits of the construction made as soon as possible. The relocation of existing utility service lines is the responsibility of the Contractor.

C. It is understood and agreed that the Contractor has considered in his bid all of the permanent and temporary utility appurtenances in their present or relocated positions as shown on the plans or as specified herein and that no additional compensation will be allowed for any delays, inconvenience, or damage sustained by him due to any interference from the said utility appurtenances or the operation of moving them.

D. The Contractor shall notify the Owner of the utility in the path of his operation, sufficiently in advance of his work, to enable the utility Owner to have a representative present.

3.09 WATERWAYS

A. Present natural and artificial waterways shall be left open to flow freely. Provide temporary dams or bypasses as necessary and/or as directed by the Engineer.

3.10 REMOVING CULVERTS

A. Do not remove culverts or other drainage structures until making satisfactory arrangements to accommodate traffic.

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3.11 REMOVAL OF PAVEMENTS AND SIDEWALKS

A. Remove all pavements, driveways, sidewalks, curbs and other such items indicated in the Drawings in a workmanlike manner. Restrict the area of each removed item to the minimum possible area that will still conform to the lines and grades of the completed construction.

B. Saw cut asphalt and concrete surfaces at the boundaries of the areas to be removed. Saw reasonably true to line and to a depth so that when removing the material, undue underbreakage or shattering of the adjacent area will not occur. The equipment for sawing shall be approved mechanical concrete saws in satisfactory working condition and adequately powered to cut the depth required.

3.12 FENCE REMOVAL AND REPLACEMENT

A. Relocate fence designated for replacement in advance of other construction. If designated on the Drawings, provide temporary fencing clear of the proposed construction. Store materials not required for the temporary fence. Replace the fence in its original alignment, if not otherwise shown on the Drawings, utilizing the existing fence materials. Replace all damaged fence materials at no additional cost to the Owner.

B. Secure areas enclosed by fences at all times that the fences are removed or the areas are otherwise accessible.

3.13 PROTECTION OF PROPERTY

A. Preserve all public and private property encountered in the construction of these improvements.

B. The Contractor shall be responsible for all damage or injury to the property of any character, during the prosecution of the work, resulting from any act, omission, neglect or misconduct in his manner or methods of executing the work, or at any time due to defective work or materials, and said responsibility will not be released until the project has been completed and accepted.

C. When or where any direct or indirect damage or injury is done to public or private property by or on account of any act, omission, neglect or misconduct in the execution of the Work, or in consequence of the non-execution thereof, the Contractor shall restore at his own expense, such property to a condition similar or equal to that existing before such damage or injury was done by repairing, rebuilding or otherwise restoring as may be directed, or he shall make good such damage or injury in an acceptable manner.

3.14 EXPLOSIVES

A. Explosives shall not be allowed for excavation.

3.15 TRENCH SAFETY

A. The current edition of Occupational Safety and Health Administration Standard for Excavation and Trench Safety Systems, 29 CFR 1926, Subpart P, is specifically incorporated

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and made a part of these specifications and contract documents as required by Arkansas Act 291 of the 79th General Assembly of 1993.

## 3.16 SITE MAINTENANCE

A. Maintain all disturbed areas of the site during the course of construction. Maintenance shall include periodic mowing of areas within and adjacent to the following: security and construction fencing, silt fencing and other erosion control devices, and equipment and material storage areas.

END OF SECTION

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# SECTION 02119

# EXCAVATED SOIL MANAGEMENT

## PART 1: GENERAL

### 1.01 SCOPE OF WORK

A. Within portions of the water main alignment described in Paragraph 1.01C below and shown on the Drawings, furnish all labor, materials, tools, equipment necessary for:

1. Screening, tracking, stockpiling, and stockpile sampling of excavated soil.

2. Obtaining and complying with NPDES Permit.

3. Designing, furnishing and operating a portable groundwater treatment system.

B. Utilize the services of an Environmental Professional (EP) to perform the work of this Section.

C. There is a potential that the Work of this Contract may involve the excavation of contaminated soil and the dewatering of contaminated groundwater based on reported releases at properties along the project alignment.

### 1.02 RELATED WORK

A. Dewatering and Drainage is included in Section 02140.

B. Trenching, Backfilling and Compaction is included in Section 02221.

C. Transportation and Disposal of Contaminated and Surplus Soil are included in Section 02125.

D. Health and Safety Plan Requirements are included in Section 13740.

### 1.03 SUBMITTALS

A. Environmental Professional – Submit the name, company name (if different from Contractor), address, telephone number and resume of the EP meeting the minimum qualifications defined in Paragraph 1.06 of this Section.

B. Soil Screening/Tracking Form – Submit sample form. Form must include all of the same information as the one included at the end of this Section.

C. Portable Groundwater Treatment System – Submit details per Paragraph 2.02 of this Section.

D. Submit soil screening logs and soil tracking sheets on a weekly basis.

E. Submit analytical data by facsimile to 617-452-8263 directly from laboratory.

F. Submit data summary tables within one week of receipt of data.

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G. Provide copy of NPDES Permit Exclusion application and approval. Provide copies of all letters and transmittals to EPA.

1.04 REGULATORY REQUIREMENTS

A. Arkansas Department of Environmental Quality (ADEQ)

1. Arkansas Contingency Plan, 310 CMR 40.0000

2. Arkansas Hazardous Waste Regulations, 310 CMR 30.000

3. Interim Remediation Waste Management Policy for Contaminated Soils, Policy # WSC-94-001.

4. Reuse and Disposal of Contaminated Soils at Arkansas Landfills, Policy # COMM-97-001.

B. United States Department of Environmental Protection (EPA)

1. Federal Hazardous Waste Regulations, 40 CFR Parts 261-268.

1.05 DEFINITIONS

A. Contaminated Soil - Excavated soil with visual or olfactory evidence of environmental impact, or with headspace readings greater than or equal to 10 ppm or with contaminant concentrations above MCP reportable concentration standards, RCS-2.

B. Uncontaminated Soil - Excavated Soil that is not Contaminated Soil

C. Surplus Soil - Excavated Soil that is Uncontaminated Soil and that is surplus.

D. Unsuitable Soil - Excavated Soil that is Uncontaminated but is physically unsuitable for use as backfill material.

E. Suitable Soil – Excavated Soil that is Uncontaminated and physically suitable for use as backfill material.

F. Contaminated Groundwater – Groundwater with contaminant concentrations above MCP reportable concentrations standards, RCGW-2.

G. Uncontaminated Groundwater – Groundwater that is not Contaminated Groundwater.

H. Soil – Soil and debris.

I. Arkansas Department of Environmental Quality (ADEQ)

J. United States Environmental Protection Agency (EPA)

K. National Pollutant Discharge Elimination System (NPDES)

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L. Environmental Professional (EP)

M. MCP reporting category defined in 310 CMR 40.0361(1)(b) - (RCS-2)

N. MCP reporting category defined in 310 CMR 40.0362(1)(b) - (RCGW-2)

1.06 EP QUALIFICATIONS

A. The EP shall have the following minimum qualifications:

1. A minimum of five years of demonstrated experience on contaminated site projects.

2. A minimum of 3 assignments where similar soil screening program has been undertaken.

3. A.S. or B.S. degree in engineering, engineering technology or science.

4. Registration as a P.E., LSP, QEP or CHMM.

5. 40 OSHA health and safety training, 8-hour OSHA supervisory training, current 8-hour OSHA refresher training and current medical monitoring.

1.07 MCP NOTIFICATION AND FILINGS

A. In the event that soil and or groundwater concentrations are determined to be present above the MCP RCS-2 and or RCGW-2 standards, the Engineer will be responsible for notifying the MDEP.

B. The Engineer will be responsible for preparing all MCP filings including but not limited to Release Notification Form (RNF), Utility-Related Abatement Measure (URAM) Plan, URAM Completion Report, Response Action Outcome (RAO) Statement.

C. The Contractor shall not anticipate any delays arising from a notification condition provided that the Contractor adheres to the requirements of this Section and Sections 02125 and 13740 including workers with current OSHA 40-hour training and medical monitoring.

PART 2: PRODUCTS

2.01 HIGH DENSITY POLYETHYLENE (HDPE) LINING

A. The high density polyethylene shall be manufactured of new, first-quality product designed and manufactured specifically for the intended use and have the following properties:

1. The material shall be 3-ply polyethylene reinforced with a non-woven grid of high strength nylon cord.

2. The material shall be U.V. resistant (black in color) and cold crack resistant to minus 40 degrees F.

3. The material shall be manufactured in a minimum 12-ft seamless width. Labels on the rolls shall identify the thickness, length, width, and manufacturer's mark number.

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2.02 PORTABLE GROUNDWATER TREATMENT SYSTEM

A. Design, furnish and operate portable groundwater treatment system to meet the contaminant discharge levels and all other requirements of the Contractor-obtained discharge permit or emergency NPDES Permit Exclusion and this Specification for the types of contaminants and flow volumes encountered.

B. Submit a design, stamped by a professional engineer registered in the State of Arkansas for a groundwater treatment system capable of processing the encountered volumes and reducing contaminant concentrations to below NPDES limits. Contaminant concentrations will be determined from the pre-construction soil and groundwater characterization specified in Paragraph 3.02 of this Section.

C. Submit documentation for the permitted operation of the groundwater treatment system including copies of all performance testing, environmental sampling data and correspondence between the Contractor and the Permitting Agency.

D. The Contractor shall obtain all necessary Federal, State and local permits required to operate the groundwater treatment system including an emergency exclusion from the NPDES permit if applicable.

E. Components of the system shall be designed and furnished by the Contractor to provide onsite groundwater treatment which meets or exceeds the discharge requirements of the Contractor obtained specific permit or emergency NPDES Permit Exclusion.

PART 3: EXECUTION

3.01 HEALTH AND SAFETY APPLICABILITY

A. As a minimum, the requirements of Section 13740, Health and Safety Plan Requirements, shall apply to all Work involving Contaminated Soil and or Contaminated Groundwater.

B. At the direction of the Engineer, decontaminate grossly contaminated equipment by means of dry methods such as brooms and absorbent towels.

C. Provide workers with personal protective equipment as necessary to comply with the Health and Safety Plan.

3.02 EXCAVATED SOIL MANAGEMENT

A. Refer to the flowchart below outlining the overall approach to managing excavated soil.

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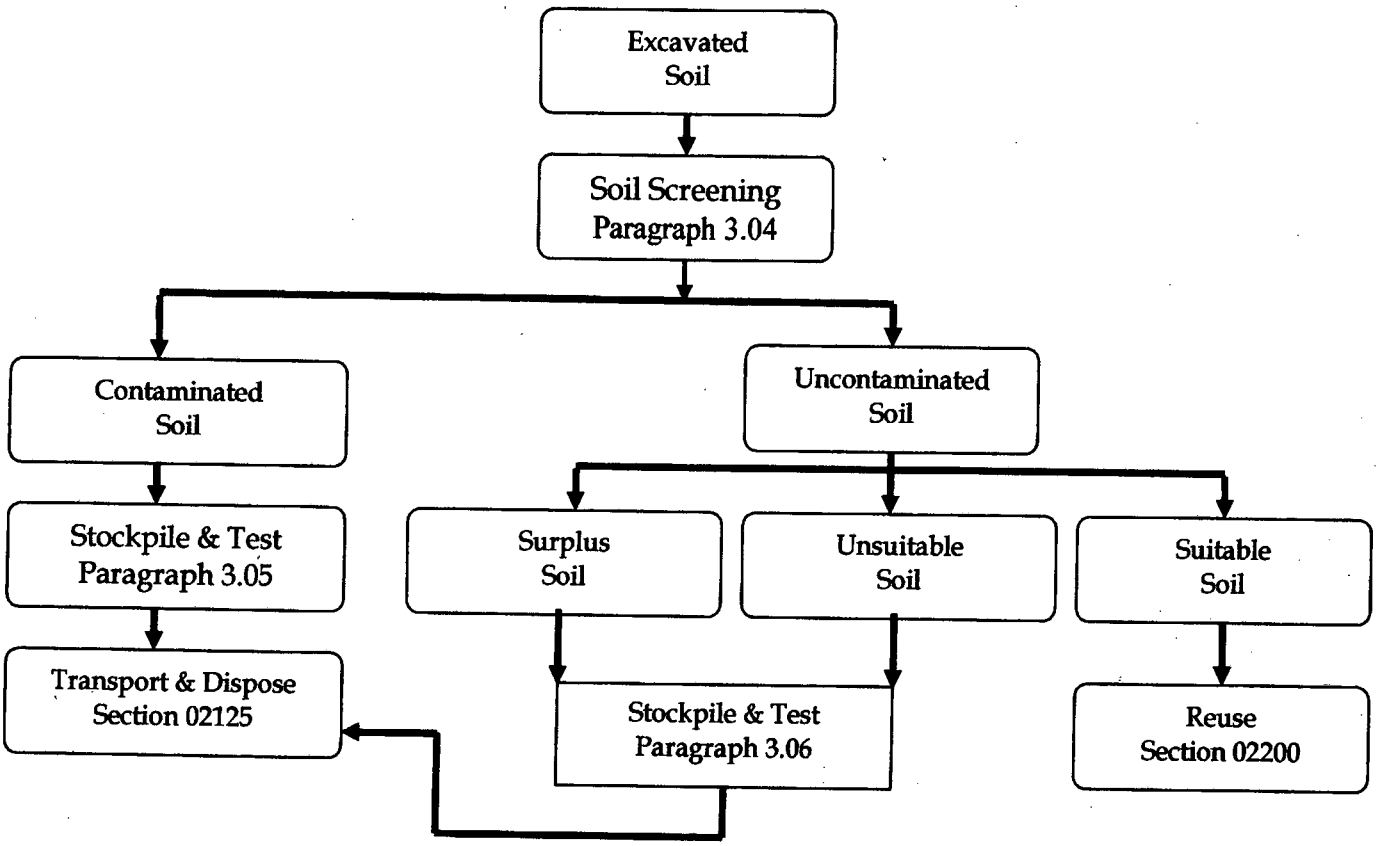


3.03 SOIL SCREENING

A. Soil screening shall be performed by an EP.

B. Soil screening shall be performed at the point of excavation.

C. Jar headspace testing shall be performed as follows:

1. Half-fill two clean 500 ml glass jars with the sample to be analyzed. Quickly cover each open top with one sheet of clean aluminum foil and screw on jar lid tightly.
2. Allow the samples to sit for at least 10 minutes. Vigorously shake jars for 15 seconds both at the beginning and end of the waiting period. Store samples inside a heated vehicle or building if temperature is below 32 degrees F.
3. Remove jar lid exposing aluminum foil seal. Quickly puncture foil seal with a photoionization detector (PID) to a point one-half of the "headspace" depth. Record PID reading within 2 to 5 seconds.
4. Calibrate and operate PID instruments to yield "total organic vapors" in ppm (v/v) as benzene with a 10.0 +/- eV lamp source.

D. Visual evidence shall include obvious staining, discoloration or other irregularity.

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E. Olfactory evidence shall include petroleum, gasoline, hydrogen sulfide ("rotten egg") or any other chemical odor.

F. Perform soil screening at a frequency of one sample per 10-wheel dump truck load. Soil screening includes visual and olfactory observations and jar headspace testing.

G. Utilize screening form included at the end of this Section or develop similar one.

H. The following decision tree shall be used to segregate excavated soil:

| Visual/Olfactory Evidence | Headspace Reading | Classification | Final Disposition |
|---|---|---|---|
| Yes | Any | Contaminated | Remove from site |
| No | ≥ 10 ppm | Contaminated | Remove from site |
| No | < 10 ppm | Uncontaminated | Reuse as backfill if suitable or remove from site if surplus or unsuitable |

## 3.04 CONTAMINATED SOIL TRACKING, STOCKPILING AND TESTING

A. Track contaminated soil from the point of excavation, through stockpiling to final disposition. Each soil stockpile shall be given a unique identifier. Utilize the tracking form included at the end of this Section or develop similar one.

B. Stockpile contaminated soil on-site in stockpiles not exceeding a volume of 100 cubic yards. Contaminated soil shall be segregated and stockpiled separately from uncontaminated soil. Contaminated Soil shall be placed on a base lined with 20 mil HDPE lining and be completely covered with 10 mil. HDPE lining. The base liner shall be bermed around the edges to prevent infiltration of stormwater or exfiltration of leachate. The berm height shall be a minimum of 12-in. Stockpiles shall be securely barricaded and clearly labeled. Hay bales shall be placed around the stockpiles.

C. Collect one representative composite sample from each 100 cubic yard stockpile. Composite sample shall consist of a minimum of 10 discrete locations collected uniformly through the entire 100 cubic yard volume. Samples collected for VOC analysis shall be collected from one discrete location as directed by the Engineer.

D. Samples shall be analyzed for the parameters listed below. The Contractor shall also be responsible for performing any additional sampling required by the disposal facilities.

| Parameter | EPA Method |
|---|---|
| Volatile Organic Compounds | 5035/8260B |
| Semi-volatile Organic Compounds | 8270C |
| Polychlorinated Biphenyls | 8082 |
| Total Petroleum Hydrocarbons | 8100 |
| RCRA 8 Metals | 6010B/7471A |
| TCLP[1] | 1311/6010B/7471A/8260B |

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[1]TCLP testing shall be performed for RCRA 8 Metals and VOCs when the total concentrations exceed the minimum theoretical levels at which TCLP criteria may be exceeded.

E. Laboratory shall be approved by the State of Arkansas. Preservation of samples for VOC analysis shall be in accordance with MDEP Policy # WSC-99-415, Preservation Techniques for Volatile Organic Compound (VOC) Analyses.

F. Within two days of receipt of soil stockpile data, provide analytical data and summary to the Engineer. Summary shall include listing of all detected compounds with comparison to MCP RCS-2 Standards and comparison to in-state lined and unlined landfill reuse criteria (Policy # COMM-97-001), in-state recycling criteria (Policy # WSC-94-400) and out-of-state reuse/recycling/disposal facility acceptance criteria.

G. The Engineer shall be responsible for approving the final disposition of all soil removed from the site. A review period of one week should be anticipated for Engineer's review of analytical data and summary.

H. Contaminated Soil stockpiles shall be removed from the site within 90 days of receipt of analytical test data or prior to the completion date of this contract, whichever is less. Dispose of Contaminated Soil in accordance with Section 02125.

## 3.05 SURPLUS, UNSUITABLE AND SUITABLE SOIL TRACKING, STOCKPILING AND TESTING

A. Track surplus, unsuitable and suitable soil from the point of excavation, through stockpiling to final disposition. Each soil stockpile shall be given a unique identifier. Utilize the tracking form included at the end of this Section or develop similar one.

B. Stockpile surplus, unsuitable and suitable soil in stockpiles not exceeding a volume of 250 cubic yards. Surplus soil can be combined with unsuitable soil. Suitable soil shall be kept separate.

C. Collect one representative composite sample from each 250 cubic yard stockpile of surplus/unsuitable soil. Perform stockpile testing as specified in Paragraphs 3.05C through H.

D. Completely cover any surplus or unsuitable soil stockpiles with concentrations above NH S-1 Standards with a 10 mil HDPE lining.

E. Reuse suitable soil in accordance with Section 02200.

F. Dispose of surplus soil and unsuitable soil in accordance with Section 02125.

## 3.06 POST EXCAVATION SAMPLING AND ANALYSIS

A. At the direction of the Engineer, collect discrete soil samples for laboratory analysis at locations and depths directed by the Engineer.

B. At the direction of the Engineer, analyze soil samples for parameters directed by the Engineer as listed below.

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| Parameter | EPA Method |
|---|---|
| Volatile Organic Compounds | 5035/8260B |
| Semi-volatile Organic Compounds | 8270C |
| Polychlorinated Biphenyls | 8082 |
| Volatile Petroleum Hydrocarbons | MADEP-VPH-DRAFT-03 |
| Extractable Petroleum Hydrocarbons | MADEP-EPH-DRAFT-04 |
| RCRA 8 Metals | 6010B/7471A |

C. Laboratory shall be approved by the State of Arkansas. Preservation of samples for VOC analysis shall be in accordance with MDEP Policy # WSC-99-415, Preservation Techniques for Volatile Organic Compound (VOC) Analyses. Comply with the Compendium of Quality Assurance and Quality Control Requirements and Performance Standards for Selected Analytical Methods, Effective August 1, 2003.

D. Provide hard copy of data within one week of sampling and tabulate data within one week of receipt of data. Compare soil data to MCP RCS-2 Standards and groundwater data to RCGW-2 Standards.

E. Payment for laboratory analysis shall be made against the allowance carried for Bid Item 19. The Contractor shall provide a unit price breakdown for the analysis listed in Paragraph 3.06B above. The cost of sample collection shall be considered incidental and separate payment for this Work will not be made.

3.07 CONTAMINATED GROUNDWATER TREATMENT

A. Dewatering shall be as specified in Section 02140.

B. Groundwater Treatment shall be as follows:

1. Treat contaminated groundwater using treatment techniques that may include separators to remove solids and non-aqueous phase liquids, pretreatment filtration to remove suspended solids followed by filtration through granular activated carbon for adsorption of dissolved phase contaminants as necessary to meet the treatment standards required in the specific NPDES permit or the emergency exclusion to the NPDES permit obtained by the Contractor.

2. Provide an on-site groundwater treatment and discharge system consisting of equipment including (as required) settling tanks, separators, pretreatment filters, granular activated carbon filtration, flow control values, total and instantaneous flow measurement instrumentation, and water quality sampling ports, properly sized for the anticipated flows and capable of treating the anticipated contaminant loading from the dewatering system selected by the Contractor.

3. At no additional cost to the Owner, the Contractor shall obtain all required permits not contained herewith and pay all fines when in violation of the permits.

4. Components of the system shall be designed and furnished by the Contractor to provide onsite groundwater treatment which meets or exceeds the discharge conditions noted

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herein, unless otherwise specified by the Contractor-obtained discharge permit or emergency exclusion from a NPDES permit.

5. Analytical reports, with quality control information, are to be reported to EPA and to the Engineer as required by the discharge permit.

6. The Contractor shall provide the EPA and the Engineer 24-hours notice of system start-up.

7. The Contractor shall protect against contaminant breakthrough, system failure, vandalism, or other incidents that may result in discharges in exceedance of applicable permit or emergency exclusion thresholds.

8. The Contractor shall collect and dispose of any free-phase products, sludge, sediments and treatment residues. The Contractor shall collect, handle and dispose of absorbent pads, booms, used treatment media including sand filters and granular activated carbon. Disposal shall be in accordance with Section 02125.

9. Discharge of any groundwater into local sanitary sewer systems is strictly prohibited.

C. Laboratory Analysis of Groundwater

1. All dewatered groundwater shall be laboratory tested as required by the NPDES exclusion permit to verify that contaminated water exceeding the discharge permit limits is not discharged inappropriately.

2. Collect samples and provide field screening and/or laboratory analysis of influent to treatment system and/or the effluent, as required by the discharge permit.

3. All laboratory testing shall be performed by a certified laboratory and in accordance with the latest versions of the appropriate EPA test methods required for proper characterization.

4. When requested by the Engineer in order to determine the need for further treatment, perform laboratory analysis on a 48 hour turnaround basis.

END OF SECTION

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SECTION 02140

DEWATERING

PART 1 GENERAL

1.01 SCOPE OF WORK

A. Furnish all labor, materials, equipment and incidentals required and remove and dispose of all surface water and groundwater entering excavations, and to prevent movement by floatation of existing structures drained to conduct improvements. In addition furnish all labor, materials, equipment and incidentals required and remove and dispose of all drain water from existing facilities.

B. Collect and properly dispose of all discharge water from dewatering and drainage systems in accordance with State and local requirements and permits.

C. Repair damage caused by dewatering and drainage system operations.

D. Remove temporary dewatering and drainage systems when no longer needed. Restore all disturbed areas.

1.02 RELATED WORK

A. Trenching, backfilling and compaction is included in Section 02221.

1.03 STATUTORY REQUIREMENTS

A. Obtain and pay for all permits required for temporary dewatering and drainage system.

B. Original permits shall be prominently displayed at the site prior to constructing dewatering and drainage system.

PART 2 PRODUCTS

2.01 MATERIALS

A. Piping, pumping equipment and all other materials required to provide dewatering of excavations and dewatering of facilities shall be suitable for the intended purpose. Standby pumping units shall be maintained at the site to be used in case of failure of the normal pumping units.

PART 3 EXECUTION

3.01 DEWATERING AND DRAINAGE SYSTEM

A. At all times during construction, provide and maintain proper equipment and facilities to remove all water entering excavations, and keep such excavations dry so as to obtain a satisfactory undisturbed

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subgrade foundation condition until the fills, structures or pipes to be built thereon have been completed to such extent that they will not be floated or otherwise damaged by allowing water levels to return to natural levels.

B. Conduct dewatering in such a manner as to preserve the undisturbed bearing capacity of the subgrade soils at proposed bottom of excavation. Construct well or sump installations with proper sand filters to prevent drawing of finer grained soil from the surrounding ground.

C. Collect water entering the excavation from surface runoff in shallow ditches around the perimeter of the excavation, drain to sumps and pump from the excavation to maintain a bottom free from standing water.

D. Take all additional precautions to prevent uplift of any structure during construction. All such arrangements shall be subject to the approval of the Engineer.

E. Dispose of drainage so that flow or seepage back into the excavated area will be prevented. Disposal area shall be approved by the Engineer.

F. Prevent flotation by maintaining a positive and continuous operation of the dewatering system. If for any reason the dewatering system is found to be inadequate, make additions, changes and replacements, as necessary, to provide a satisfactory system at no additional cost to the Owner. All damage resulting from failure to properly dewater excavations shall be repaired to the satisfaction of the Engineer at no additional cost to the Owner.

G. At all times during construction provide and maintain proper equipment and facilities to remove all water which leaks by closed gates, valves, temporary plugs, etc. to maintain a properly dewatered facility. Provide temporary plugs, piping and valves as required to maintain properly dewatered facilities.

END OF SECTION

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# SECTION 02200

# EARTHWORK

## PART 1: GENERAL

### 1.01 SCOPE OF WORK

A. Furnish all labor, materials, equipment and incidentals required; and perform all excavation work and hauling, grading, placement and compaction of fill and backfill, disposal of unsuitable waste and surplus earthen materials, and topsoiling. Perform all work within the limits necessary for the construction of the improvements and in conformance with the lines, grades, thicknesses and typical cross sections shown on the Drawings and as specified herein.

### 1.02 RELATED WORK

A. Section 02100 – Site Preparation

B. Section 02140 – Dewatering and Drainage

C. Section 02220 - Excavation, Backfilling, and Compaction (Structures)

D. Section 02221 - Trenching, Backfilling, & Compaction (Pipelines)

E. Section 02273 – Geotextile Fabric

F. Section 02930 – Seeding for Site Restoration

### 1.03 REFERENCE STANDARDS

A. American Association of State Highway and Transportation Officials (AASHTO), latest edition:

1. AASHTO M 57 – Materials for Embankments and Subgrades.

2. AASHTO M 145 – The Classification of Soils and Soil-Aggregate Mixtures for Highway Construction Purposes.

3. AASHTO M 146 – Terms Relating to Subgrade, Soil-Aggregate, and Fill Materials.

4. AASHTO T 99 – The Moisture-Density Relations of Soils Using a 5.5 lb. [2.5 kg] Rammer and a 12 -in. [305 mm] Drop.

5. AASHTO T 180 – Moisture-Density Relations of Soils Using a 10-lb. [4.54 kg] Rammer and an 18-in [457 mm] Drop.

6. AASHTO T 310 – In-Place Density and Moisture Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).

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B. American Society for Testing and Materials (ASTM), latest edition:

1. ASTM D2487 – Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System).

C. Occupational Safety and Health Administration (OSHA), latest edition:

1. All excavation, trenching and related sheeting, bracing, etc., shall comply with the requirements of OSHA safety standards (29 CFR Part 1926.650 Subpart P – Excavation) and any applicable State requirements. Where conflict between OSHA and State regulations exists, the more stringent requirements shall apply.

2. The current edition of Occupational Safety and Health Administration Standard for Excavation and Trench Safety Systems, 29 CFR 1926, Subpart P, is specifically incorporated and made a part of these specifications and contract documents as required by Arkansas Act 291 of the 79th General Assembly of 1993.

1.04 DEFINITIONS

A. Boulder Excavation: The removal of boulders or boulder pieces larger than 1 cubic yard in volume that requires drilling and blasting or other approved splitting and breaking methods, or that requires increasing a trench or excavated area more than 18-inches.

B. Common Excavation: The removal of all material not classified as boulder, concrete or rock excavation. Classify as Common Excavation any piece of boulder or concrete, 1 cubic yard or less in volume, which can be mechanically removed without drilling and blasting, breaking, splitting, or increasing the trench or excavated area as specified.

C. Concrete Excavation: The removal of concrete pieces larger than 1 cubic yard in volume that requires drilling and blasting or other approved splitting and breaking methods, or that requires increasing a trench or excavated area more than 18-inches. Concrete excavation includes materials composed of Portland cement that are not identified in other sections of the Specifications and excluding manholes, drainage structures, vaults, piping or other appurtenances which are typically classified as Common Excavation.

D. Exploratory Excavation: The removal and replacement of materials from locations shown on the Drawings, as directed by the Engineer, or for the Contractor's benefit for the purpose of investigating underground conditions and to identify potential utility conflicts between existing and proposed facilities. Unless otherwise indicated in the Bid Proposal, the Owner will not make separate payment for exploratory excavation.

E. Rock Excavation: Sedimentary rock which, by demonstration, cannot be excavated with equipment weighing at least 50,000-lbs. and having at least 140 net horsepower, equipped with a ripper or similar approved equipment without prior systematic drilling and blasting or breaking with power-operated rock excavation tools. The Engineer may waive the demonstration if the material encountered is well-defined rock.

F. Trench Excavation: The removal of materials encountered in trenches to the depths as shown on the Drawings or as directed by the Engineer. See Section 02221 –Trenching, Backfilling, and Compaction.

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1.05 SUBMITTALS

A. See Section 01300 – Submittals, for submittal procedures.

B. Submit an excavation and trench safety plan to the Engineer for review.

C. Furnish test data to indicate compliance of all earthwork with this specification, including off-site material proposed for the Project.

1.06 QUALITY ASSURANCE

A. Furnish manufacturer or supplier certification for all products and materials. Coordinate with the Engineer the testing of all materials from off-site sources including select material, clay, and topsoil.

B. Unless otherwise noted, conduct testing in accordance with the following minimum frequencies:

1. Determine a moisture-density relationship for each type of subgrade material encountered, and conduct testing in accordance with AASHTO T 99 or T 180.

2. Conduct field density and moisture testing of earthwork subgrade in accordance with AASHTO T 310. Unless otherwise indicated, in-place density and moisture testing frequency shall be one (1) test per 5,000 sq.-ft. of subgrade.

3. Conduct field density and moisture testing of embankment fill and backfill in accordance with AASHTO T 310. Unless otherwise indicated, in-place density and moisture testing frequency shall be one (1) test per 750 sq.-yds. of area in each lift of embankment.

1.07 COORDINATION

A. Completely coordinate the work of this Section with the work of other sections. Verify at the site both the dimensions and work of other trades adjoining items of work in this Section before commencement of items herein specified.

B. Furnish to the pertinent trades all items included under this Section that are to be built into the work of other sections.

1.08 FIELD MEASUREMENTS

A. Take field measurements at the site to verify or supplement indicated dimensions and to ensure proper coordination of all other construction items.

PART 2: PRODUCTS

2.01 COMMON FILL

A. Common Fill: Soil material substantially free of organic materials, topsoil, wood, peat, trash or other objectionable materials that may be compressible through decomposition or that may not be properly compacted. Common fill shall not contain rocks or stones larger than 6-in. in

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the largest diameter, and shall have a maximum of 75 percent passing the No. 40 sieve and a maximum of 20 percent passing the No. 200 sieve. Common fill shall not contain granite blocks, broken concrete, masonry rubble or other similar materials. It shall have physical properties such that it can be readily spread and compacted during filling. Snow, ice and frozen soil are not permitted.

2.02 SELECT BACKFILL

A. Select (Structural) Backfill: Granular material with a maximum particle size of 3-in., graded from coarse to fine, conforming to AASHTO classification A-1, A-2-4 or A-2-5.

B. Materials conforming to AASHTO A-2-6 and having a plasticity index not exceeding 15 may be submitted for review and evaluation by the Engineer. However, evaluation of such material shall not imply any obligation of the Engineer to accept it for use in the Work.

C. On-site soils are not considered suitable for Select (Structural) Backfill.

D. The Contractor shall furnish, at his expense, test data to indicate compliance of select material with this specification.

E. See Sections 02220 and 02221 for additional backfill requirements.

PART 3: EXECUTION

3.01 GENERAL

A. Earthwork shall consist of all excavation, embankment, dressing, shaping and finishing necessary for the construction, compaction and completion of all subgrades and other earthwork indicated on the Drawings to the required alignment, grade and typical cross section as shown on the Drawings or as directed by the Engineer.

B. Do not excavate below grade except where rock is encountered or the Engineer directs the removal of unstable material. Should the Contractor, through negligence or other fault, excavate below the designated lines, he shall replace the excavation with approved materials, in an approved manner and condition at his own expense. The Engineer shall have complete control over the excavation, moving, placing, and disposition of all material, and shall determine the suitability of material to be placed in embankments.

C. The Contractor shall inform and satisfy himself as to the character, quantity and distribution of all material to be excavated.

D. Excavation work shall be performed to provide drainage at all times. When directed, temporary drains and drainage ditches shall be installed to intercept or divert surface water that may affect the work. Operations on earthwork shall be suspended at any time when satisfactory results cannot be obtained because of rain, freezing weather, or other unsatisfactory conditions.

E. Material determined by the Engineer to be unsatisfactory for subgrade construction shall be classified as undercut excavation and shall be removed as directed by the Engineer. Backfill undercut areas with select material from off-site borrow areas unless otherwise directed by

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the Engineer. Dispose of all unsuitable material removed from undercut areas on site as directed by the Resident Engineer.

F. Excavate all rock or unyielding material that cannot be shaped to conform to the subgrade elevations to a minimum depth of 6-in. below the finished subgrade elevation. Fill the excavation to grade with approved material.

G. Use only suitable excavated material in the formation of embankments and backfills unless otherwise specified. Place the excavated material in areas of the embankment as directed by the Engineer. Remove muck, peat, matted roots, or other unsatisfactory material for subgrade foundation to the depth directed by the Engineer. Dispose of all excess material on site as shown on the grading plan or as directed by the Resident Engineer.

H. Do not commence construction of embankments or backfilling until the area has been inspected and approved by the Engineer. Clear and grub fill areas to remove all vegetation and objectionable material. Remove all topsoil prior to the commencement of filling. Backfill all depressions or holes beneath the ground surface, whether caused by grubbing or other reasons with suitable material and compacted before commencing construction of the subgrade. Scarify areas to be filled to a depth of 6-in. prior to placement of fill. Construct fill to the specified grade in uniform layers parallel to the finished surface and not more than 8-in. in thickness, loose measurement. The material in the layers shall be of the proper moisture content before compacting. Wetting or drying of the material and manipulation when necessary to secure a uniform moisture content throughout the layer shall be required.

I. Accomplish backfilling of trenches for storm drainage facilities, water line improvements and utility relocations as specified in other sections of these specifications. Compact backfill to the specified density.

J. All excavation depths shall be confirmed, in writing, by the Project Geotechnical Engineer prior to the start of construction to ensure subsurface conditions are suitable for the intended structure loads.

## 3.02 SOIL COMPACTION

A. In the preparation of subgrades and earthwork, compact the material to provide a stable, uniform surface. Compact the subgrade to the required density and stability and show no evidence of displacement or rutting. Provide proof rolling to evaluate the stability of the subgrade and as directed by the Engineer. Accomplish proof rolling with a loaded dump truck with a minimum weight of 10,000 pounds per axle.

B. Where modification of the subgrade is specified, stabilization and compaction requirements shall be as specified in other sections of these specifications.

C. Compact soils to the following standards. Base the maximum dry density on the Standard Test, AASHTO T 99.

1. Compact all soils in the upper 12-in. of the subgrade beneath pavements or driveways to 100% density.

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2. Compact all other soils to 95% density.

3. Trench densities shall be as specified for that type trench excavation. When no density is specified, the densities specified in 1 and 2 above shall apply.

D. The moisture content of the material being compacted shall be within a range of two percent below the optimum to a maximum of two percent above. Adjust the moisture content of the material to maintain the range specified by the addition of water or by aeration.

3.03 SUBGRADES

A. Construct the completed subgrade surface to the lines, grades and cross sections shown on the Drawings or as directed by the Engineer. Correct any irregularities or depressions that develop by loosening and recompacting the material until the surface is smooth and uniform. Should the subgrade be rutted prior to the next phase of construction, reshape and recompact the subgrade without additional compensation to the Contractor.

B. Shaping and compacting of subgrades prior to construction of pavements shall be as specified in other sections of these specifications.

3.04 ROCK AND BOULDER EXCAVATION

A. Excavate and remove rock and boulders to the widths and depths directed by the Engineer. Where the Bid Proposal includes a separate payment for rock and/or boulder removal, excavate and remove overburden and expose the rock to allow the Engineer to measure the rock prior to removal.

B. Explosives are prohibited for rock or boulder excavation.

C. Dispose of all excavated rock and boulders at a designated location on-site as directed by the Engineer.

3.05 TOPSOIL

A. Stockpile topsoil stripped from within the project limits at the on-site stockpile areas designated on the Drawings or as directed by the Resident Engineer. Stockpile the topsoil in such a manner that other materials will not become intermixed and interfere with reuse of topsoil. Strip topsoil from the designated areas to a minimum depth of 6-in. unless otherwise indicated on the plans.

B. When suitable topsoil is not available on the site, locate and obtain a supply subject to the approval of the Engineer. Notify the Engineer sufficiently in advance of operations in order that necessary measurements and tests can be made.

C. Immediately prior to dumping and spreading the topsoil on any area, loosen the surface by disking or by other means approved by the Engineer. Loosen the subgrade to a minimum depth of 2-in. to facilitate bonding of the topsoil. Clear the surface of all litter and stones larger than 2-in.

D. Spread the topsoil evenly on the prepared areas to a uniform depth of 4-in. after compaction. Do not spread topsoil when the ground or topsoil is frozen, excessively wet, or otherwise in a

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condition detrimental to the work. Carry out spreading so that seeding operations can proceed with a minimum of soil preparation or tilling. After spreading is completed, the topsoil shall be smooth-graded and the surface left at the prescribed grades in an even, properly compacted condition. Prevent the formation of low places or pockets where water will stand on the finished subgrade. Light rolling with placing or spreading equipment and wetting if needed, will be required to consolidate the topsoil to the finished grades.

3.06 TOLERANCES

A. Grading shall be accomplished to the tolerances listed below for the various areas and classes of work as shown. The tolerances listed are maximum variations that will be acceptable for each class of work without exception.

1. Form and compact the subgrade beneath structures to within 0.05 feet of the finished subgrade as established by grade hubs or stakes.

2. Rough grade all areas outside of those mentioned in the previous paragraphs and which do not receive any type of a finished structure shall be rough graded to within 0.10 feet of the finished grade after the necessary allowances have been made for the thickness of topsoil. This tolerance shall be reduced as necessary to provide drainage at all points and to prevent the formation of water pockets in the finished grading.

B. Any deviation in excess of the amount shown above shall be corrected by loosening, adding or removing materials, reshaping and recompacting by sprinkling and rolling.

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SECTION 02220

# EXCAVATION, BACKFILLING AND GRADING (STRUCTURES)

## PART 1: GENERAL

### 1.01 SCOPE OF WORK

A. Furnish all labor, materials, equipment and incidentals necessary to perform all excavation work and grading; place and compact backfill and fill; and dispose of unsuitable, waste and surplus materials as shown on the Drawings and as specified herein.

B. Provide the services of a licensed professional engineer, registered in the State in which the Work is located, to prepare temporary excavation support system designs and submittals.

C. Furnish and install temporary excavation support systems, including sheeting, shoring and bracing, to insure the safety of personnel and protect adjacent structures, piping, etc, in accordance with Federal, State and local laws, regulations and requirements.

### 1.02 STATUTORY REQUIREMENTS

A. All excavation, trenching, sheeting, bracing, etc. shall comply with the requirements of OSHA excavation safety standards (29 CFR Part 1926.650 Subpart P – Excavation). Where conflicts between OSHA, state and local regulations exist, the most stringent requirement shall apply.

### 1.03 RELATED WORK

A. Section 02100 – Site Preparation.

B. Section 02140 – Dewatering and Drainage.

C. Section 02200 – Earthwork.

D. Section 02221 - Trenching, Backfilling, & Compaction (Pipelines)

E. Section 02325 – Sheeting, Waling, and Shoring

F. Section 02273 – Geotextile Fabric

G. Section 02930 – Seeding for Site Restoration.

### 1.04 REFERENCE STANDARDS

A. American Association of State Highway and Transportation Officials (AASHTO), latest edition:

1. AASHTO M 57 – Materials for Embankments and Subgrades.

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2. AASHTO M 145 – The Classification of Soils and Soil-Aggregate Mixtures for Highway Construction Purposes.

3. AASHTO M 146 – Terms Relating to Subgrade, Soil-Aggregate, and Fill Materials.

4. AASHTO T 99 – The Moisture-Density Relations of Soils Using a 5.5 lb. [2.5 kg] Rammer and a 12 -in. [305 mm] Drop.

5. AASHTO T 180 – Moisture-Density Relations of Soils Using a 10-lb. [4.54 kg] Rammer and an 18-in [457 mm] Drop.

6. AASHTO T 310 – In-Place Density and Moisture Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).

B. American Society for Testing and Materials (ASTM), latest edition:

1. ASTM C33 – Standard Specification for Concrete Aggregates.

2. ASTM D698 – Test Method for Laboratory Compaction Characteristics of Soils Using Standard Efforts.

3. ASTM D1557 – Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort.

4. ASTM D4318 – Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.

1.05 SUBMITTALS

A. See Section 01300 – Submittals, for submittal procedures.

B. Submit the proposed methods of construction, including excavation, backfilling and filling, compaction, and designs for excavation support systems for the various portions of the Work. Excavation support system designs shall be prepared by a licensed professional engineer, registered in the State in which the work is located, having a minimum of five (5) years of professional experience in the design and construction of excavation support systems (see paragraph 1.01.B). Review by the Engineer will be for information purposes only. Contractor shall remain responsible for the adequacy and safety of construction means, methods and techniques.

1.06 QUALITY ASSURANCE

A. Furnish manufacturer or supplier certification for all products and materials. Coordinate with the Engineer the testing of all materials from off-site sources including select material and clay.

B. Unless otherwise noted, conduct testing in accordance with the following minimum frequencies:

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1. Determine a moisture-density relationship for each type of subgrade and backfill material encountered, and conduct testing in accordance with AASHTO T 99 or T 180 (ASTM D698 or D1557).

2. Conduct field density and moisture testing of earthwork subgrade below all structures in accordance with AASHTO T 310. Unless otherwise indicated, in-place density and moisture testing frequency shall be one (1) test per 5,000 sq.-ft. of subgrade.

3. Conduct field density and moisture testing of structural backfill in accordance with AASHTO T 310. Unless otherwise indicated, in-place density and moisture testing frequency shall be one (1) test per 5,000 sq.-ft. of area in each lift of embankment or backfill material.

1.07 DEFINITIONS

A. Where the phrase "in-the-dry" is used in these Specifications, it shall be defined to mean a soil condition such that the in-place moisture content of the soil at that time is no more than two percentage points above the optimum moisture content of that soil as determined by the laboratory test of the moisture-density relation appropriate to the specified level of compaction.

B. Where used in this Specification "structures" refers to all buildings, wet wells, manholes and below grade vaults. Stormwater structures and duct banks are not considered structures in this context.

1.08 PROJECT SITE REQUIREMENTS

A. SUBSURFACE CONDITIONS

1. A geotechnical investigation report is made available for the Contractor's information to be used at the Contractor's risk. Do not assume that materials other than those disclosed by the borings will not be encountered, or that the proportions or character of the various materials will not vary from those indicated in the geotechnical investigation report. Any conclusions drawn by the Contractor from the investigation report including the character of the materials to be encountered and degree of difficulty to be expected in the performance of the Work are the sole responsibility of the Contractor.

2. The Contractor is encouraged to perform an independent subsurface investigation. Coordinate access to the site with the Owner.

3. No claim for extra compensation or extension of time will be considered because of any variation in site, soil, or water conditions from those indicated in the geotechnical report to those actually encountered.

PART 2: PRODUCTS

2.01 MATERIALS

A. Common fill shall consist of mineral soil substantially free from organic materials, loam, wood, trash, and other objectionable materials which may be compressible or which cannot

be compacted. Common fill shall not contain stones larger than 6 inches in largest diameter, granite blocks, broken concrete, masonry ruble, or other similar materials. It shall have physical properties such that it can be readily spread and compacted during filling. Snow, ice, or trash shall not be permitted. It shall have a plasticity index of less than 18 (per ASTM D4318). Native material (excluding sandy, lean clays) conforming to these requirements may be used as common fill.

B. Select fill and structural fill shall be granular material with a maximum particle size of 3-inches, graded from coarse to fine, and conforming to AASHTO classification A-1, A-2-4, or A-2-5.

1. Materials conforming to AASHTO A-2-6 and having a plasticity index not exceeding 15 may be submitted for review and evaluation by the Engineer. However, evaluation of such material shall not imply any obligation of the Engineer to accept it for use in the Work.

C. Crushed stone shall be well graded containing several sizes of particles ranging from ¾-inch maximum to No. 4. Unless otherwise approved by the Engineer, the material shall meet the requirements of ASTM C33, Gradation 67.

D. Timber used for excavation support systems shall be pressure-treated with wood preservatives for ground contact.

E. Geotextiles specified for use at structure excavations shall be as required in the Drawings and conform to the requirements of Specification Section 02273.

## PART 3: EXECUTION

### 3.01 PREPARATION

A. Test Pits

1. Perform exploratory excavation work (test pits) for the purpose of verifying the location of underground utilities and structures and to check for unknown utilities and structures, prior to commencing excavation work.

2. Backfill test pits as soon as the desired information has been obtained. Stabilize backfilled surfaces in accordance with approved erosion and sedimentation control plans.

B. Dewatering and Drainage Systems

1. Temporary dewatering and drainage systems shall be in place and operational prior to beginning excavation work per Specification Section 02140.

### 3.02 EXCAVATION SUPPORT

A. Furnish, install, monitor and maintain excavation support (e.g., shoring, sheeting, bracing, trench boxes, etc.) as required by Federal, State or local laws, ordinances, regulations and safety requirements. Support the sides of excavation, to prevent any movement that could in any way reduce the width of the excavation below that necessary for proper construction and

protect adjacent structures from undermining, settlement or other damage. Take care to prevent the formation of voids outside of sheeting. If voids occur behind sheeting, immediately backfill and compact the voids with common fill material. Fill voids in locations that cannot be properly backfilled and compacted with lean concrete.

B. Install excavation supports outside the neat lines of foundations. Supports shall be plumb and securely braced and tied in position. Excavation support shall be adequate to withstand all pressures to which the supports will be subjected. Correct any movement or bulging of supports to provide the necessary clearances, dimensions and structural integrity.

C. Conform to the additional requirements of Specification Section 02325 as applicable.

D. Excavation Supports Left in Place

1. Excavation supports that are required to remain in place, if applicable, are indicated on the Drawings.

2. The Owner or Engineer may direct that certain excavation supports remain in place, or be cut off at any specific elevation. Supports directed by the Owner or Engineer to be left in place and not so designated on the Drawings or otherwise specified herein to remain in place, will be paid for in accordance with Article 11 of the General Conditions. If the Contractor believes that such a directive increases Contractor's cost and would thereby entitle Contractor to a change in contract cost, Contractor shall notify the Engineer in accordance with the applicable article(s) in the General Conditions pertaining to changes in the work.

3. The right of the Owner or Engineer to direct that certain excavation supports remain in place shall not be construed as creating any obligation on the Owner or Engineer to give such direction, nor shall failure to give such direction relieve the Contractor from liability for damages to persons or property occurring from or upon the work occasioned by negligence or otherwise, growing out of a failure on the part of the Contractor to leave in place sufficient excavation supports to prevent any movement of the ground or damage to adjacent structures.

E. Remove excavation supports carefully and in such manner so as not to endanger the Work or other adjacent structures, utilities, or property. Fill all voids left or caused by withdrawal of supports immediately with compacted sand.

## 3.03 STRUCTURAL EXCAVATION PROCEDURES

A. Excavations for structures shall be suitably wide for construction of the structures, including excavation supports, dewatering and drainage systems and working clearances.

B. Excavation shall be performed in-the-dry and shall be accomplished by methods, which preserve the undisturbed state of subgrade soils. Drainage and dewatering systems shall be in place and operational prior to beginning excavation work. In no case shall the earth be plowed, scraped or excavated by any means so near to the finished subgrade that would disturb the finished subgrade. Hand excavation of the final three to six inches may be required to obtain a satisfactory, undisturbed subgrade. Subgrade soils that become soft, loose, "quick", or otherwise unsatisfactory for support of structures as a result of inadequate

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excavation, dewatering, or other construction methods shall be removed and replaced with crushed stone, subject to prior approval by the Engineer, at no additional cost to the Owner.

C. Subgrade Preparation

1. All structures unless otherwise shown on the Drawings or otherwise specified elsewhere in this Section:

   a. Compact the top 12-inches of subgrade to a minimum of 100 percent (100%) standard proctor (ASTM D698).

   b. Where structures are supported by piles, compact the top 12-inches of subgrade to a minimum of 95 percent (95%) standard proctor (ASTM D698).

2. Where existing subgrade contains a significant amount of clay, cohesive soils, or soft soils identified by the Project Geotechnical Engineer, overexcavate sufficiently below the bottom of the structure and place a 6-inch minimum working mat of crushed stone or lean concrete. Prior to placement of the working mat, compact the top 12-inches of existing subgrade to a minimum of 100 percent (100%) standard proctor (ASTM D698).

3. Refer to the Drawings for structure specific excavation requirements.

4. Where indicated on the Drawings, provide a heavy geotextile such as Mirafi 180N or an approved equal conforming to the requirements of Specification Section 02273.

D. When excavations have reached the required subgrade, including any allowances for working mats or base materials, prior to the placement of working mats or base materials, notify the soils testing laboratory to verify the suitability of the existing subgrade soils for the anticipated foundation and structural loadings. If the existing subgrade soils are determined to be unsuitable, direction will be provided by the Engineer regarding removal and replacement with suitable materials. If Contractor believes that such direction would increase Contractor's cost and would thereby entitle Contractor to a change in Contract cost, Contractor shall notify the Engineer in accordance with the applicable article(s) in the General Conditions pertaining to changes in the work.

E. Over-excavation beyond the limits and depths required by the Contract Documents shall be replaced at no additional cost to the Owner by bedding rock or other approved material subject to the prior approval of the Engineer.

## 3.04 GENERAL FILLING AND BACKFILLING PROCEDURES

A. Fill and backfill materials shall be placed in lifts to suit the specified compaction requirements to the lines and grades required, making allowances for settlement and placement of cover materials (i.e. topsoil, sod, etc). Soft spots or uncompacted areas shall be corrected.

B. Fill and backfill materials shall not be placed on frozen surfaces, or surfaces covered by snow or ice. Fill and backfill material shall be free of snow, ice and frozen earth.

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C. Each layer of fill shall be compacted to a mass density not less than the minimum density specified. The moisture content of compacted backfill shall be within 2 percent (+/-) of the optimum moisture content.

D. Fill adjacent to structures shall be compacted by means of hand tamping or manually directed power tampers or plate vibrators. Unless otherwise specified, heavy equipment including backhoe mounted power tampers, or vibrating compactors and manually directed vibratory rollers, shall not be operated within 2 feet of any structure. Towed or self-propelled vibrating rollers shall not be operated within 10 feet of any structure. Compaction by means of drop weights operating from a crane or hoist will not be permitted. Maximum layer thickness of fill lift for hand compactors or manually directed power tampers shall not exceed 6-inches.

## 3.05 FILL AND BACKFILL PROCEDURES

A. Fill and backfill material placed immediately adjacent to and within 10 feet of all structures shall be select (structural) fill. All structure water-tightness tests and damproofing/waterproofing shall be completed prior to placing fill or backfill around structures. Place and compact select fill in even lifts of 6-inches (compacted thickness) uniformly around the structure.

B. Common fill may be used in areas beyond those designated for select fill unless shown or specified otherwise. Common fill shall be placed in even lifts having a maximum thickness (measured before compaction) of 12-inches.

C. Fill required beneath building slabs or slabs on grade (except sidewalks) shall be select (structural) fill. Place and compact structural fill in even lifts of 6-inches (compacted thickness).

## 3.06 EMBANKMENT FILL PROCEDURES

A. Prior to placing embankment fill materials, all organic materials (including peat and loam) and loose inorganic silt material (loess) shall be removed from areas beneath the embankments. If the subgrade slopes are excessive, the subgrade shall be stepped to produce a stable, horizontal surface for the placement of embankment materials. The existing subgrade shall then be scarified to a depth of at least 6-inches.

B. Embankment fill shall consist of common fill material and shall be placed and compacted in even lifts of 12-inches (compacted thickness).

C. Rock may be used in embankment fill only with prior, written approval of the Engineer.

## 3.07 COMPACTION REQUIREMENTS

A. Ten feet around structures including backfill for buried structures: Compact the top 12-inches of existing subgrade and each layer of fill or backfill to a minimum of 95 percent standard proctor (ASTM D698) at or near its optimum moisture content.

B. Embankments (except under roadways), lawn or unimproved areas: Compact the top 6-inches of existing subgrade and each layer of fill or backfill to a minimum of 95 percent standard proctor (ASTM D698) at or near its optimum moisture content.

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C. Beneath building slabs and slabs on grade (except sidewalks): Compact the top 12-inches of existing subgrade (and each layer of fill if applicable) to a minimum of 95 percent per modified proctor (ASTM D1557) at or near its optimum moisture content.

D. Sidewalks: Compact the top 6-inches of existing subgrade (and each 6-inches layer of fill if applicable) to a minimum of 100 percent standard proctor (ASTM D698) at or near its optimum moisture content. Compact 4-inches of Class 7 fill to a minimum of 95% standard proctor.

E. Roads, paved areas and roadway embankments: Compact the top 12-inches of existing subgrade and each layer of fill or backfill to a minimum of 100 percent standard proctor (ASTM D698) at or near its optimum moisture content.

3.08 DISPOSAL OF UNSUITABLE WASTE AND/OR SURPLUS EXCAVATED MATERIAL

A. Remove and dispose of unsuitable waste off-site. Materials may be temporarily stockpiled in an area within the limits of construction that do not disrupt construction activities, create any nuisances or safety hazards, or otherwise restrict access to the site of the Work. Suitable excess excavation will be placed in on-site spoil areas as detailed on the grading plan or as directed by the Resident Engineer.

3.09 GRADING

A. Perform grading to the lines and grades shown on the Drawings. Remove and dispose of all objectionable material encountered within the limits indicated. Subgrades shall be completely and continuously drained and dewatered throughout the grading process. Install temporary drains, drainage ditches, etc, to intercept or divert surface water that may affect the execution or condition of grading work.

B. If at the time of grading it is not possible to place any material in its proper section of the Work, it shall be stockpiled in approved areas for later use. No extra payment will be made for the stockpiling or double handling of excavated material.

C. Stones or rock fragments larger than 4-inches in their greatest dimensions will not be permitted within the top 6-inches of the finished grade of fills and embankments.

D. In cut areas, all loose or protruding rocks in slopes shall be removed to the line or finished grade of the slope. Uniformly dress all cut and fill slopes to the slope, cross-section and alignment shown on the Drawings unless otherwise directed by the Engineer.

END OF SECTION

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SECTION 02221

# TRENCHING, BACKFILLING, AND COMPACTION (PIPELINES)

## PART 1: GENERAL

### 1.01 SCOPE OF WORK

A. Furnish all labor, materials, equipment and incidentals required; and perform all trenching for pipelines and appurtenances, including excavation, bedding, backfilling, disposal of surplus or unsatisfactory soil material, and restoration of trench surfaces and easements.

B. Excavation shall extend to the width and depth shown on the Drawings or as specified herein, and it shall provide suitable room for installing pipe, structures and appurtenances.

### 1.02 RELATED WORK

B. Section 02100 - Site Preparation.

C. Section 02140 - Dewatering and Drainage.

D. Section 02200 - Earthwork.

E. Section 02220 - Excavation, Backfilling, and Compaction (Structures)

F. Section 02270 - Erosion and Sediment Control.

G. Section 02530 - Sanitary Sewers.

H. Section 02930 - Seeding for Site Restoration.

I. Section 03300 - Cast-In-Place Concrete.

### 1.03 REFERENCE STANDARDS

A. American Association of State Highway and Transportation Officials (AASHTO), latest edition:

1. AASHTO M 57 – Materials for Embankments and Subgrades.

2. AASHTO M 145 – The Classification of Soils and Soil-Aggregate Mixtures for Highway Construction Purposes.

3. AASHTO M 146 – Terms Relating to Subgrade, Soil-Aggregate, and Fill Material.

4. AASHTO T 99 – The Moisture-Density Relations of Soils Using a 5.5 lb. (2.5 kg) Rammer and a 12 in. (305 mm) Drop.

5. AASHTO T 180 – Moisture – Density Relations of Soils Using a 10-lb. (4.45 kg) Rammer and an 18-in. (457 mm) Drop.

6. AASHTO T 310 – In-Place Density and Moisture Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).

B. American Society for Testing and Materials (ASTM), latest edition:

1. ASTM C33 – Specification for Concrete Aggregates.

2. ASTM D2321 - Standard Practice for Underground Installation of Thermoplastic Pipe for Sewer and Other Gravity-Flow Applications

3. ASTM D2487 – Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System).

C. Arkansas Highway and Transportation Department Standard Specifications, latest edition:

1. Section 303 - Aggregate Base Course

D. Occupational Safety and Health Administration (OSHA), latest edition:

1. All excavation, trenching and related sheeting, bracing, etc., shall comply with the requirements of OSHA safety standards (29 CFR Part 1926.650 Subpart P – Excavation) and any applicable State requirements. Where conflict between OSHA and State regulations exists, the more stringent requirements shall apply.

2. The current edition of Occupational Safety and Health Administration Standard for Excavation and Trench Safety Systems, 29 CFR 1926, Subpart P, is specifically incorporated and made a part of these specifications and contract documents as required by Arkansas Act 291 of the 79th General Assembly of 1993.

## 1.04 SUBMITTALS

A. See Section 01300 - Submittals, for submittal procedures.

B. Submit the proposed method of backfilling and compaction to the Engineer for review.

C. Submit an excavation and trench safety plan to the Engineer for review.

D. Furnish test data to indicate compliance of backfill, bedding and compaction with this specification.

## 1.05 QUALITY ASSURANCE

A. Furnish manufacturer or supplier certification for all products and materials. Coordinate with the Engineer the testing of all materials from off-site sources including select material, topsoil, sand, rock, and crushed stone.

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B. Unless otherwise noted, conduct testing in accordance with the following minimum frequencies:

1. Determine a moisture-density relationship for each type of subgrade and backfill material encountered, and conduct testing in accordance with AASHTO T 99 or T 180.

2. Conduct field density and moisture testing of initial trench subgrade and all backfill in accordance with AASHTO T 310. Unless otherwise indicated, in-place density and moisture testing frequency shall be one (1) test per 400 lin.-ft. (every other lift) of trench backfill.

1.06 COORDINATION

A. Completely coordinate the work of this Section with the work of other sections. Verify at the site both the dimensions and work of other trades adjoining items of work in this Section before commencement of items herein specified.

B. Furnish to the pertinent trades all items included under this Section that are to be built into the work of other sections.

1.07 FIELD MEASUREMENTS

A. Take field measurements at the site to verify or supplement indicated dimensions and to ensure proper coordination of all other construction items.

PART 2 PRODUCTS

2.01 BEDDING

A. GENERAL

1. Pipe bedding shall conform to the class specified. When no bedding class is specified, the requirements for Class "1" Bedding shall apply.

B. CLASS "1" BEDDING

1. Class 1 bedding material shall conform to class 1A embedment materials in accordance with ASTM D 2321, latest edition. Material shall meet the grading requirements of ASTM C 33, gradation 67, commonly referred to as ASTM #67 or 3/4" concrete aggregate. Maximum aggregate size shall be 3/4 inch. This includes materials such as crushed stone or rock, broken coral, crushed slag, cinders, or crushed shells.

C. CLASS "B" GRANULAR BEDDING

1. Class "B" Granular Bedding: Crushed stone or gravel, well graded, and containing several sizes of particles ranging from ¾-in. maximum to No. 4. Unless otherwise approved by the Engineer, the material shall meet the requirements of ASTM C33, Gradation 67.

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D. CLASS "D" BEDDING

1. Class "D" Bedding: Firm soil excavated from the trench and free of rocks, which will provide uniform bearing for the full length of the pipe barrel.

2. Excavate bell holes in the trench at each joint to permit proper jointing and to prevent the joint of the pipe from being a point of support. Correct over excavation of any portion of the trench with thoroughly compacted soil material approved by the Engineer.

2.02 SELECT BACKFILL

A. Select Backfill: Granular material with a maximum particle size of 3-in., graded from coarse to fine, conforming to AASHTO classification A-1, A-2-4 or A-2-5, or a sandy or gravely clay conforming to classification A-2-6 or A-6 with the exception that the plasticity index shall not exceed 15.

B. The Contractor shall furnish, at his expense, test data to indicate compliance of select material with this specification.

C. Class 7 backfill material shall conform to the requirements of Arkansas Highway and Transportation Department (AHTD), 303 - AGGREGATE BASE COURSE, Section 303.02.

PART 3: EXECUTION

3.01 GENERAL

A. Excavate the trench so that the pipe can be laid to the required lines and grades as indicated on the Drawings. Do not deviate from the required line or grade except with the written consent of the Engineer.

B. Grade the trench to the approximate depth shown on the plans and maintain a depth that will provide not less than 30-in. of cover from the top of the pipe to the finished surface of the ground. Install the pipe to a grade such that the entire line will have a minimum number of high and low points. At utility or street crossings requiring greater line depth, install the pipe approach to the crossing on a gradual and uniform grade.

C. Whenever obstructions not shown on the plans are encountered during the progress of the work and interfere to such an extent that an alteration in the plans is required, the Engineer shall have the authority to change the plans and order a deviation from the line and grade or arrange with the owners of the structures for the removal, relocation or reconstruction of the obstructions.

D. Furnish temporary support and provide adequate protection and maintenance of all underground and surface utility structures, drains, conduits, sewers and other structures encountered in the progress of the work at no additional cost to the Owner. Where the grade or alignment of the pipe is obstructed by existing structures, the Contractor shall permanently support, relocate, remove or reconstruct the obstruction in cooperation with the owners of such utility structures. Determine the location of existing underground utility structures,

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including coordinating utility location services, examining available records, and making all explorations and excavations necessary to determine the exact location of the underground utility.

E. Proceed with caution in the excavation and preparation of the trench to determine the exact location of underground structures and utilities, both known and unknown. The Contractor is responsible for locating all on-site facilities including but not limited to on-site electrical, process control wiring or fiber optic, and process piping. Failure to locate these facilities and subsequent damage will be repaired at no additional cost to the Owner.

F. Do not advance the excavation of trenches more than 150 feet ahead of the completed pipe work and completed backfill without permission from the Engineer. Refer to other sections of these Specifications for the requirements for cutting and replacing pavements.

G. Lay water mains at least 10 feet horizontally from any existing or proposed gravity or pressure sewer. Measure the distance from edge to edge. In cases where it is not practical to maintain a 10-ft. separation, deviation must be specifically approved by State regulatory officials and the Engineer. Vertical separation of water and sewer mains at crossings shall provide for a minimum of 18-in. of distance from the outside of the water line to the outside of the sewer line. At crossings, one full length of water pipe shall be laid such that both joints are installed as far from the sewer as possible. Special structural support of the water and/or sewer line may be required by the Design Engineer, i.e., clay, concrete, or pipe encasement.

H. Cut and repair street and highway crossings in accordance with the requirements of the local municipality or government agency. Obtain street cut permits for any and all such cuts.

3.02 EXCAVATION

A. Excavate all the material encountered within the lines and grades shown on the Drawings and as specified and directed by the Engineer. Saw all paved driveway, parking lot and street cuts at the trench limits or as indicated on the Drawings.

B. Below a point 12-in. above the outside top of the pipe, the trench shall have vertical sides and shall have a minimum width equal to the outside pipe diameter plus 18-in. and a maximum width equal the outside pipe diameter plus 30-in.

C. At any point where the width of the lower portion of the trench exceeds these limits, the Contractor shall take corrective measures. As directed by the Engineer, the Contractor shall provide either pipe of adequate strength, special pipe embedment, or a concrete cradle as required by the loading conditions. The Contractor shall furnish and install these corrective items at no additional cost to the Owner.

D. Stockpile material suitable for backfilling in an orderly manner a sufficient distance from the banks of the trench to avoid overloading and to prevent slides or cave-ins. Remove or waste all excavated materials not required or unsuitable for backfill as indicated in the Specifications or as directed by the Engineer.

E. Where necessary to protect the labor, the work or adjacent property, the Contractor shall provide and install shoring. The material used shall be of suitable dimensions and strength to prevent the settlement or movement of the ground adjacent to the trench and to prevent

damage to surface or subsurface structures. The adequacy and need of the sheeting and bracing shall be the complete responsibility of the Contractor. The shoring shall remain in place until the backfill has proceeded to a point where it can safely be removed, except that, if in the opinion of the Engineer, damage is likely to result from withdrawing shoring, it shall remain in place. No separate payment will be made for sheeting, shoring and bracing.

F. If the soil at the bottom of the trench is unstable and in such condition that it cannot be properly graded, excavate the trench to a depth determined by the Engineer and backfill to grade with crushed stone or gravel well compacted by tamping.

G. Dewater all excavation before any construction is undertaken therein. Lay all pipe in dry trenches and place all concrete only upon dry and firm foundation material. The Contractor shall pump, bail, or temporarily provide drainage for any water encountered.

H. Should the specified methods of dewatering the trenches be unsuccessful, excavate the trench to a depth of approximately 6-in. below grade. Backfill the trench to grade with gravel bedding. Form a sump below the gravel to provide a place for a pump to take suction and thus lower the water level to a point below the bottoms of the pipe joints. Continue the pumping until the joints have been placed and the presence of water will not injure them. Do not commence backfilling until the trench has been dewatered.

I. If rock is present at the grade line of the trench, excavate it to an elevation approximately 6-in. below grade. Rock shall consist of sedimentary or other types of rock that cannot be excavated without the use of rippers or impact hammers. Rock excavation shall include boulders and deposits of concrete with a volume of ½ cubic yard or more. Backfill the trench to grade with crushed stone or gravel. Place this backfill prior to laying the pipe. Dispose of all excavated rock from on site as directed by the Engineer.

J. When necessary, construct an impervious dam or bulkhead in the trench to interrupt the unnatural flow of groundwater after construction. Key the dam into the trench bottom and sidewalls.

K. Avoid heavy machinery traffic above installed pipe until at least 3-ft. of trench backfill is placed and compacted. Monitor pipe deflections during trench backfill.

3.03 BEDDING

A. Bed all pipe in accordance with Subsection 2.01.

B. Prior to installation of the pipe, shape the bedding to provide uniform support for the bottom quadrant of the pipe barrel.

C. Accomplish the placement of material on each side of pipe (haunching) and immediately above the top of the pipe (initial backfill) in a manner that will prevent displacement or deflection of the pipe.

3.04 BACKFILLING

A. Backfill all trenches immediately after the pipe is laid and approved. Install backfill by methods that will not disturb the pipe. Repair pavement cuts with paving materials of the

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type and design of the original surface. Do not commence pavement repair until the Contractor has achieved proper subgrade compaction. Such backfilling, before testing, shall not relieve the Contractor of responsibility for correction of leaks in the line.

B. Backfill material shall consist of on-site material excavated from the trenches except where the Drawings require the use of special backfill materials or as directed by the Engineer. On-site backfill material shall be free of rocks, clods or frozen masses over 3-in. in diameter or organic matter. The Engineer will approve backfill material prior to placement in the trench.

C. Place backfill up to a level of 12-in. above the top of the pipe by hand shoveling or other approved methods, and deposit backfill in maximum layers of 4-in. Compact each layer by mechanical tamping. Do not displace pipe during tamping of the backfill. Control the moisture content of the backfill material as required to obtain the specified compaction.

D. From a point 12-in. above the top of the pipe, place backfill by any approved method that will not injure or disturb the pipe and will result in the specified compaction.

E. Trench backfill density requirements vary with the location and depth of the trench. Generally, perform compaction tests in every second lift of any fill area to demonstrate the compliance with the specifications. The percentage of compactive requirements for the various locations are the minimum densities that will be accepted. All densities specified herein are based on the maximum dry density of the material obtained by the standard method of test as determined by AASHTO T 99, latest revision. Field density determination shall conform to AASHTO T 310.

| Location and Depth | Percent Compaction |
|---|---|
| Bottom of trench to 12-in. above the top of the pipe. | 95% |
| Upper portions of the trench not under pavement. | 95% |
| Upper portions of the trench under streets, driveways, sidewalks and paved areas. Subgrade (top 12-in.). | 100% |
| Remainder of fill. | 100% |

F. When conflicts exist between these densities due to location or depth of trench, obtain the higher specified density.

H. Replace or rework materials or workmanship that fail to meet the specified requirements.

I. All trenches shall be backfilled, settled, and the ground restored to its original condition as soon as possible after the pipe is installed. Any unnecessary delay in restoring trenches to their original condition shall constitute just cause for stopping all other work until the trenches are so restored. If at any time within 12 months after the completion and final acceptance of the work embraced in this Contract, there shall be any settlement of the trenches requiring repairs to be made, the Owner may notify the Contractor to make such repairs as may be necessary. Should the Contractor fail to do so within 15 days after the date of such notice, or should the nature of such defect be such as to require immediate attention, the Owner shall make such repairs as may be necessary, and bill the actual cost of such repairs to the Contractor.

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## 3.05 SLURRY BACKFILL

A. Where designated by the Engineer, the Contractor shall backfill trenches with a plant mixed slurry of sand, cement, and fly ash in a ratio of 3,400 lb.: 150 lb.: 100 lb. This mixture shall meet the minimum criteria of a compressive strength of 300 psi at 28 days. The Contractor shall use this material to help facilitate the reapplication of traffic over the trenches across streets and driveways where dictated by the Engineer. The Engineer may modify the design as required by the construction conditions. Place slurry to neat trench lines as indicated on the plans, not to exceed a trench quantity 24-in. wider than the diameter of the pipe in the trench.

B. The Engineer may elect to place a temporary surface over the slurry. The Contractor shall consult the trenching details in the Drawings as to the required depth of bedding, slurry and surface material depths. This procedure may be used for drainage, water lines, sanitary sewer lines or other pavement crossings.

C. Allow utility backfill to achieve a 24 hour set before allowing traffic on it, or before the placement of base course or paving materials. Protect utility backfill against frost and rapid drying.

## 3.06 EXPLOSIVES

A. Explosives shall not be allowed for excavation.

END OF SECTION

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SECTION 02230

GRANULAR FILL MATERIALS

PART 1: GENERAL

1.01 SCOPE OF WORK

A. Furnish all labor, materials, equipment and incidentals required and install granular fill materials as shown on the Drawings and as specified herein. Associated work includes testing, sample collection, excavation, loading, shipping, delivering, stockpiling, placement and installation of granular fill materials.

1.02 RELATED WORK

A. Earthwork is included in Section 02200.

B. PVC Pipe is included in Section 02622.

1.03 SUBMITTALS

A. Submit, in accordance with Section 01300, and within 30 calendar days following the Effective Date of the Agreement and before furnishing and installing the granular fill material the following information:

1. Identification of the granular fill supplier.

2. A signed certification from the supplier, listing permits (including types and permit numbers) demonstrating that the granular fill source is in full compliance with applicable standards and regulations.

3. A description of the installation procedure for leachate collection system; a schedule to include granular fill installation for list applicable layers such as subbase, lateral drainage layer, etc. and a list of installation equipment.

4. A Quality Control/Quality Assurance Plan for the lateral drainage layer installation.

5. Documentation and related past experience in accordance with Paragraph 1.06 below.

6. Three 10 lb samples for laboratory testing from each granular fill and coarse aggregate source to be used in this project.

1.04 REFERENCE STANDARDS

A. American Society for Testing and Materials (ASTM)

1. ASTM D422 - Standard Test Method for Particle-Size Analysis of Soils.

2. ASTM D698 – Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort(12,400 ft-lbf/ft$^3$ (600 kN-m/m$^3$))

3. ASTM D854 - Standard Test Method for Specific Gravity of Soils Solids by Water Pycnometer

4. ASTM D1556 – Standard Test Method for Density and Unit Weight of Soil in Place by Sand-Cone Method

5. ASTM D1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3(2,700 kN-m/m3)).

6. ASTM D2216 - Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass.

7. ASTM D2434 - Standard Test Method for Permeability of Granular Soils (Constant Head)

8. ASTM D2487 - Classification of Soils for Engineering Purposes (Unified Soil Classification System)

9. ASTM D2488 - Standard Practice for Description and Identification of Soils (Visual-Manual Procedure).

10. ASTM D2937 – Standard Test Method for Density of Soil in Place by the Drive-Cylinder Method

11. ASTM D2974 - Standard Test Methods for Moisture, Ash, and Organic Matter of Peat and Other Organic Soils.

12. ASTM D6938 – Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)

13. ASTM C40 - Standard Test Method for Organic Impurities in Fine Aggregates for Concrete.

14. ASTM C136 - Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.

15. ASTM C289 - Standard Test Method for Potential Alkali-Silica Reactivity of Aggregates (Chemical Method).

16. ASTM D75 - Standard Practice for Sampling Aggregates.

17. ASTM D3042 - Standard Test Method for Insoluble Residue in Carbonate Aggregates.

18. ASTM D4373 - Standard Test Method for Rapid Determination of Carbonate Content of Soils.

B. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

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1.05 QUALITY ASSURANCE

A. The Quality Control and Quality Assurance consists of laboratory conformance testing of samples supplied from each granular fill and coarse aggregate source and quality control during installation.

B. The Owner will retain an independent laboratory (QAL) that has adequate equipment to perform permeability tests and provide results in a timely manner in accordance with this Section. Coordinate and schedule all tests as required by the Drawings and as specified herein.

C. Conformance testing requirements are specified in Paragraph 2.02 below. The purpose of conformance testing is to assure that the supplied granular fill materials from each source conform to this Section and specified permeability.

D. Field quality control requirements are specified in Paragraph 3.02 below. The purpose of field quality control procedures is to assure that the lateral drainage layer has been installed in accordance with this Section meeting the specified hydraulic conductivity.

1.06 QUALIFICATIONS

A. The work shall be performed by a firm that has experience in processing and installation of lateral drainage layers and protective soil cover on top of synthetic liners. The firm shall demonstrate proven experience by providing a minimum of five similar completed projects with the following information:

1. Type and thickness of installed material and permeability.

2. Name and purpose of facility, its location and date of installation.

3. Name of Owner and design engineer. Name and telephone number of contact at the facility who can discuss the project.

B. The supplier shall show evidence of an adequate supply of material which is relatively homogenous within a designated mine area which is properly permitted by the appropriate Federal, State and local agencies.

1.07 DELIVERY, STORAGE AND HANDLING

A. If granular fill materials are delivered to the site prior to placement approval, materials shall be stockpiled on site in areas as [directed] [shown on the Drawings]. Provision shall be implemented to minimize surface water impact on the stockpile. Removal and placement of granular fill material shall be done in a manner to minimize intrusion of soils adjacent to and beneath the stockpile.

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PART 2: PRODUCTS

2.01 MATERIAL

A. Sand Material

1. Sand shall be of well-graded inorganic non-calcareous material, free from organic substance and other deleterious matter with a minimum permeability of [1 x $10^{-2}$] cm/sec or greater at 95% of the maximum density as determined by ASTM D1557. Sand shall be in particle size gradation within the following limits (ASTM D422) and have a Unified Soil Classification of SW per ASTM D2487.

| Sieve Size | Percent Passing by Weight |
|---|---|
| No. 4 | 100 |
| No. 200 | 5 maximum |

2. Sand that will be in contact with geosynthetic liners shall have rounded to subrounded particle shapes per ASTM D2488 to avoid possible liner damage.

3. Sand material shall have an organic content of no more than 2% (ASTM D2974).

4. Sand material shall have a carbonate content of no more than 5 % (ASTM D4373).

5. The material shall contain no stones, shell fragments or deleterious material larger than 1/2 –inch in its largest dimension and is subject to testing at specified intervals.

6. Sand used above the liner shall not contain more than 5 % by weight material finer than No. 200 mesh sieve.]

B. Coarse Aggregate

1. Washed coarse aggregate shall be used for bedding material around the leachate collection pipes, wrapped with geotextile fabric as shown on the Drawings and as specified herein. The coarse aggregate shall be sound, hard, durable, non-carbonate, resistant to weathering and shall be free of overburden, spoil, shale, limestone and organic material.

2. The coarse aggregate shall be sub-rounded to rounded particles as defined in ASTM D2488 and shall have particle size gradation within the following limits (ASTM D422).

| Sieve Size | Percent Passing by Weight |
|---|---|
| 2-in | 100 |
| 1-1/2-in | 90 to 100 |
| 1-in | 20 to 55 |
| 3/4-in | 0 to 15 |
| 3/8-in | 0 to 5 |
| No. 16 | 0 |

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[2. The coarse aggregate shall be washed river rock having sub-rounded to rounded particles as defined in ASTM D2488 and meeting FDOT Coarse Aggregate No. 4 size as specified in Section 901 of the FDOT standards.

| Sieve Size | Percent Passing by Weight |
|---|---|
| 2-in | 100 |
| 1-1/2-in | 90 to 100 |
| 1-in | 20 to 55 |
| 3/4-in | 0 to 15 |
| 3/8-in | 0 to 5 |

3. Coarse aggregate shall have a carbonate content of no more than 1% (ASTM D4373)

2.02 CONFORMANCE TESTING

A. Granular Fill Material

1. Conformance testing shall be performed by the QAL on samples from each source of granular fill material to assure compliance with this Section. The following tests shall be performed on the samples.

   a. Sieve Analysis (ASTM D422) at the beginning of screening (if screened) and at daily intervals during screening or every 1,500 cy whichever is more frequent.

   b. Specific Gravity (ASTM D854) every 2,500 cy.

   c. Carbonate (ASTM D4373) every 2,500 cy.

   d. Organic Content (ASTM D2974) every 2,500 cy.

   e. Compaction Characteristics (ASTM D1557) every 2,500 cy.

   f. Laboratory Density - Permeability Relationship (ASTM D2434) for 95% maximum density as determined by ASTM D1557 every 5,000 cy.

B. Coarse Aggregate

1. Conformance testing shall be performed by the QAL on samples from each source of granular fill material to assure compliance with this Section. The following tests shall be performed on at least one sample per 100 ton of coarse aggregate.

   a. Gradation analysis (ASTM D422)

   b. Carbonate Content (ASTM D4373)

   c. Particle Shape (ASTM D2488)

PART 3: EXECUTION

3.01 GRANULAR FILL PLACEMENT

A. Processed sand placement below the geosynthetic clay liner shall be placed in one 6-inch lift, and compacted to 95% of the maximum density as determined by ASTM D1557. Thickness of the subbase shall be measured and recorded in accordance with Section (01 71 20) (01050). Compaction testing shall be performed at 1,000 cy intervals.

B. After installation completion and acceptance of the liner system and related work activities, place the granular fill material to thickness and in areas shown on the Drawings.

C. During the placement of the granular fill material above the geomembrane, no construction equipment shall be allowed directly on the geomembrane, geonet/geocomposite, or geotextile, and any damage shall be repaired immediately in accordance with Section 02770. CONTRACTOR shall maintain the minimum thickness of cover as specified herein when using spreading, grading, or compaction equipment.

D. Care shall be taken to protect the geomembrane, geonet/geocomposite, geotextile, liner system. Sand ramps shall be provided at down slopes and in other heavily traveled areas. Only large radius turns by the loader and other equipment shall be permitted as sharp turns may damage the liner.

E. Granular materials shall not be placed over a fold in the geomembrane, geonet/geocomposite, or geotextile.

F. The sand layer above the geosynthetics shall be carefully placed with the first lift a minimum of 18 inches, and compacted with a low ground pressure dozer or similar equipment that will achieve the specified density without damaging the leachate collection system or geosynthetic layers. The final grade shall be laid to elevations as shown on the Drawings. The sand layer shall be compacted to a minimum of 90% of the maximum density as determined by ASTM D1557.

G. Sand shall be placed on the side slopes starting at the toe of the slope and working toward the top of the berm.

H. Drainage layer material can only be spread when the geomembrane is taut or stretched evenly over the base of the landfill. The drainage layer material shall not be spread when the geomembrane is elongated due to higher daytime temperatures and exposure to sun. Provisions must be made to cover the geomembrane under non-elongated conditions.

I. The moisture content of the sand material shall be at or slightly above the optimum moisture content during the compaction and smoothing of the sand layer by the smooth drum roller. If, in the opinion of the Engineer, the sand is too dry for proper compaction, spray the sand with a sufficient quantity of clean water to bring the sand layer to the proper moisture content. No compaction shall take place if the sand is excessively saturated.

J. No sand material shall be placed, spread, or compacted while the ground or sand is frozen or thawing or during unfavorable weather conditions. The sand surface must be made smooth and free from ruts or indentations at the end of any working day when significant precipitation

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is forecast and/or at the completion of the compaction operations in that area in order to prevent saturation of the sand material.

K. Trenches for the leachate collection pipes shall be excavated within the granular fill where shown on the Drawings. Exercise special care not to disturb or damage the geomembrane geonet/geocomposite, or geotextile. If a backhoe is used to construct the trench, a rubber modification section shall be installed on the bucket to protect the geosynthetics. All areas of the liner damaged shall be immediately repaired as directed by the Engineer.

L. A 2-in minimum layer of sand shall be placed in the bottom of the trench followed by a geotextile fabric. The leachate piping shall be installed, and shall be backfilled with coarse aggregate to the depth and width shown on the Drawings. Care shall be taken during backfilling of the pipe to assure the pipe will not be crushed or otherwise damaged. The geotextile fabric shall then be overlapped at least 8-in over the coarse aggregate.

M. Following construction of the leachate piping, the granular fill material shall be brought to final grade and compacted as specified herein.

3.02 FIELD QUALITY CONTROL

A. The sand layer thickness shall be measured periodically throughout the day in accordance with Section 01050 during construction to confirm that the thickness of the installed material is in accordance with the Drawings.

B. Nuclear Density and Moisture Content per ASTM D6938 shall be measured every 22,000 square feet of each lift of installed material. Note that extreme care must be taken when measuring above a geomembrane system to avoid damage. Nuclear density gauge shall not be used until correlated at the jobsite with in place soil density as measured by ASTM D1556 (taking care not to damage the geomembrane liner system) and every 40 measurements or every 2 weeks, whichever is more frequent, for each installed material and each nuclear test device utilized.

C. Any sample or area tested shall be rejected, removed and replaced if it does not meet the requirements of the technical specifications. Reconstructed areas shall have feathered, overlapping edges that tie into adjacent fill material.

END OF SECTION

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SECTION 02270

SEDIMENTATION AND EROSION CONTROL

PART 1: GENERAL

1.01 SCOPE OF WORK

A. Furnish all labor, materials, equipment and incidentals; and install, maintain, remove, and clean up erosion and sedimentation controls as shown on the Drawings and as specified herein.

B. The work shall include installation of temporary access ways and staging areas, silt fences, rock ditch checks, sediment removal and disposal, erosion control device maintenance, removal of temporary erosion control devices, temporary mulching, excelsior matting installation, and final cleanup.

C. The Drawings include typical erosion and sedimentation control details for the Contractor's convenience and do not relieve him from installing different or additional devices where required to properly protect the site.

D. For all construction sites with five (5) or more acres disturbed by construction activity, the Owner will submit a Notice of Intent (NOI) for Dischargers of Storm Water Runoff Associated with Medium or Large Construction Activity Authorized Under NPDES General Permit ARR150000 to the Arkansas Department of Environmental Quality (ADEQ) prior to the commencement of construction activities.

E. A Storm Water Pollution Prevention Plan is anticipated to be required for this project. The Owner will prepare a Storm Water Pollution Prevention Plan (SWP3) for use on this Project, however, the Contractor agrees to become a signatory to the SWP3. The Contractor further agrees to abide by the conditions of the SWP3, furnish and install all features of the SWP3, and amend the SWP3 as necessary to accommodate site conditions and construction elements.

F. If required, the Owner will submit the Notice of Termination for Dischargers of Storm Water Runoff Associated with Medium or Large Construction Activity Authorized under NPDES General Permit ARR150000 to ADEQ following final stabilization of the construction site.

1.02 RELATED WORK

A. Section 01562 – Dust Control.

B. Section 02100 – Site Preparation.

C. Section 02140 – Dewatering and Drainage.

D. Section 02200 – Earthwork.

E. Section 02220 - Excavation, Backfilling, and Compaction (Structures)

F. Section 02221- Trenching, Backfilling, & Compaction (Pipelines)

G. Section 02930 – Seeding for Site Restoration.

1.03 REFERENCED SPECIFICATIONS

A. Arkansas State Highway and Transportation Department – Standard Specifications for Highway Construction, latest edition.

1.04 DEFINITIONS

A. Best Management Practices (BMPs): Schedules of activities, prohibitions of practices, maintenance procedures, and other management practices to prevent or reduce the pollution of waters of the State. BMPs also include treatment requirements, operating procedures, and practices to control plant site runoff, spillage or leaks, sludge or waste disposal, or drainage from raw material storage.

1.05 SUBMITTALS

A. See Section 01300 – Submittals, for submittal procedures.

B. For all construction projects the Contractor shall:

1. Prior to the start of construction, submit a schedule for installing temporary and permanent erosion control work. Work shall not commence until the Engineer approves the erosion control schedule and methods of operation.

2. Sign and return three (3) copies of the SWP3 to the Engineer. Designate a qualified inspector responsible for performing inspections as specified in the SWP3.

3. Submit any amendments as necessary to the SWP3 to prevent sediment from leaving the construction site.

1.06 QUALITY ASSURANCE

A. Install and maintain all sedimentation control devices, including accepted Best Management Practices (BMPs), necessary to prevent the movement of sediment from the construction site to off-site areas or into the stream system via surface runoff or underground drainage systems. Install measures in addition to those shown on the Drawings as necessary to prevent the movement of sediment off-site. Maintain, remove and clean up sedimentation devices at no additional cost to the Owner.

B. Sedimentation and erosion control measures shall conform to the requirements of the SWP3.

1.07 REGULATORY REQUIREMENTS

A. Implement the SWP3 according to the requirements of the General Permit.

B. Do not discharge pollutants such as chemicals, fuels, lubricants, asphalt, raw sewage, concrete drum wash water, and other harmful waste into or alongside any waters of the

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United States. Dispose of these pollutants in accordance with governing State and Federal regulations and in accordance with the SWP3 and the General Permit.

1.08 COORDINATION

A. Coordinate the work of this Section with the work of other sections. Verify at the site both the dimensions and work of other trades adjoining items of work in this Section before commencement of items herein specified.

B. Furnish to the pertinent trades all items included under this Section that are to be built into the work of other sections.

1.09 FIELD MEASUREMENTS

A. Take field measurements at the site to verify or supplement indicated dimensions and to ensure proper coordination of all other construction items.

PART 2: PRODUCTS

2.01 MATERIALS

A. Crushed stone for sediment filtration devices, driveway and access ways, and staging areas: Hard, durable, crushed stone, 1½-in. to 6-in. conforming to the Arkansas State Highway and Transportation Department Standard Specification for Stone Backfill.

B. Rock ditch check rip-rap: Sound, durable rock, roughly rectangular in shape conforming to following:

1. Well graded within the following limits.

| Weight of Stone | Percent Finer by Weight |
|---|---|
| 40-lbs. | 100% |
| 12-lbs. | 50% |
| 3-lbs. | 0% |

2. Free of rounded stones, boulders, sandstone or similar soft stone.

3. Free of overburden, spoil, shale and organic material.

C. Silt fence: Prefabricated commercial product made of woven polypropylene, ultraviolet resistant material similar to Mirafi Silt Fence by TenCate Mirafi, Inc. or approved equal.

D. Filter box mesh: ¼-in. galvanized steel woven wire mesh or hardware cloth.

E. Straw mulch: Threshed straw of oats, wheat, barley, or rye, free of noxious weeds, mold or other objectionable material. Straw mulch shall contain at least 50-percent (50%) by weight of material that is 10-in. or longer. Provide straw in an air-dry condition, suitable for placement with blower equipment.

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F. Straw mulch tackifier: Commercial product of latex acrylic copolymer or an organic tackifier, specifically manufactured for use with straw mulch. Asphalt tackifiers are not allowed for this Project.

G. Erosion control blanket: 100% agricultural straw matrix, stitch bonded with degradable thread between two (2) photobiodegradable polypropylene nettings, similar to Model S150 Double Net Short-Term Blanket by North American Green or approved equal.

PART 3: EXECUTION

3.01 GENERAL

A. Comply with the requirements of the Federal Clean Water Act; the Arkansas Water and Air Pollution Control Act 472, as amended; and the regulations, orders, or decrees issued pursuant thereto. In case of conflict between these regulations, orders, or decrees and the provisions shown on the construction plans, the more restrictive requirements shall apply.

B. The National Pollutant Discharge Elimination System (NPDES) requires permit coverage in order to discharge storm water associated with construction sites into waters of the United States. This coverage within Arkansas is obtained under ADEQ General Permit ARR150000.

C. The Owner will file a Notice of Intent (NOI) and develop a Storm Water Pollution Prevention Plan (SWP3) for construction sites of five (5) acres or greater. The Contractor shall Implement the SWP3 according to the requirements of the General Permit and be prepared to install, construct, repair, and maintain erosion and sedimentation control items throughout the contract period. When the project site is stabilized per the requirements of the NPDES General Permit, the Contractor shall provide written notice to the Owner. Once the site is deemed stabilized, the Owner will file the required Notice of Termination (NOT).

D. Operations performed by the Contractor on lands located outside the proposed areas of disturbance or project limits such as borrow pits, plant sites, waste sites or other facilities, may require separate coverage under NPDES permit and shall be the responsibility of the Contractor.

E. If the Contractor fails to properly maintain, install, or construct erosion and sedimentation control items, the Owner may take the following actions: cessation of the Work, withholding of Contractor payments, suspension of the project, or default of the Contractor.

F. Additional erosion and sedimentation control work required due to Contractor negligence, carelessness, or failure to install permanent controls as scheduled, shall be performed by the Contractor at no additional cost to the Owner. In addition, the Contractor may be assessed damages resulting from negligence in complying with the SWP3 at the rate assessed against the Owner by the permitting authority.

G. The work and measures associated with erosion and sedimentation control shall include but not be limited to the following best management practices (BMP's).

1. Staging of Earthwork Activities: Schedule excavation and moving of soil materials so that the smallest possible areas will be unprotected and subject to possible erosion for the shortest time feasible.

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2. Seeding: Apply seed and fertilizer and establish a stand of grass to protect disturbed areas in accordance with Section 02920, Seeding for Site Restoration.

3. Mulching: Apply mulch to provide temporary protection to soil surfaces from erosion.

4. Solid Sod: Install solid bermuda sod as needed for temporary erosion control.

5. Diversions: Grade ditches to divert water away from work areas and/or to collect runoff from work areas for treatment and safe disposal.

6. Stream Crossings: Install culverts or bridges where equipment must cross streams.

7. Sediment Basins: Construct sediment basins to settle and filter out sediment from eroding areas to protect properties and streams below the construction site.

8. Baled Straw Filter Barriers: Install temporary baled straw filter barriers to protect drainage inlets and junction boxes and trap sediment in ditches from areas of limited runoff. Remove bales when permanent measures are installed.

9. Waterways: Utilize waterways for the safe disposal of filtered runoff from fields, diversions and other structures or measures.

H. Install and monitor a rain gauge on the construction site. Maintain a daily record of rainfall amounts.

I. Maintain a signed copy of the SWP3 at the job-site throughout the contract period.

3.02 INSTALLATION

A. Install silt fences as shown on the Drawings and in accordance with the manufacturer's recommendations. Position silt fences to prevent off-site movement of sediment produced by construction activities.

B. Prior to setting the access casting, install filter boxes on drainage inlets and junction boxes as shown on the Drawings and in accordance with the manufacturer's recommendations.

C. As an alternative to filter boxes, install baled straw filter barrierssurrounded by silt fence around drainage inlets and junction boxes as shown on the Drawings and prior to setting the access casting.

D. Install rock ditch checks across stream and drainage channels just below a sandbag wall and as shown on the Drawings.

E. Install stabilized construction entrances with 6-in. (minimum) of crushed stone as shown on the Drawings.

F. Install 4-in. (minimum) crushed stone surface on staging areas and other access ways as shown on the Drawings.

G. The above requirements shall be in place prior to the initiation of construction activities.

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3.03 MAINTENANCE AND INSPECTIONS

A. Inspections

1. Visually inspect all erosion and sedimentation control devices in accordance with the SWP3 and promptly after every ½-in. or greater rainstorm. If such inspection reveals that additional measures are needed to prevent movement of sediment to off-site areas, promptly install additional devices as needed and note any corrective measures on the inspection form in the SWP3.

2. Promptly repair sediment controls in need of maintenance within the time frame established in the SWP3.

B. Device Maintenance

1. Silt Fences

a. Remove accumulated sediment once it builds up to 50% of the height of the fabric.

b. Replace damaged fabric, or patch with a 2-ft. minimum overlap.

c. Make other repairs as necessary to ensure that the fence is filtering all runoff directed to the fence.

2. Filter Boxes

a. Replace crushed stone when it becomes saturated with silt.

3. Rock Ditch Check

a. Muck out trapped silt from dewatering operations when it has built up to within 6-in. of the top of the berm.

b. Replace crushed stone filter when saturated with silt.

4. Add crushed stone to driveway entrances, access ways, and staging areas as necessary to maintain a firm surface free of ruts and mudholes.

3.04 TEMPORARY MULCHING

A. Apply temporary mulch and seed to areas where rough grading has been completed but final grading is not anticipated to begin within 14 days of the completion of rough grading.

B. Apply straw mulch at the rate of 100-lbs./1,000-sq.-ft. and tackify with latex acrylic copolymer at a rate and diluted in a ratio per manufacturer's instructions.

3.05 EROSION CONTROL BLANKETS

A. Install erosion control blankets in all seeded drainage swales and ditches as shown on the Drawings and as directed by the Engineer in accordance with manufacturer's instructions. Finish grade, fertilize and seed the area before the blanket is applied.

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B. Unroll the blanket such that the netting is on top and the fibers in contact with the soil over the entire area. Lap the blankets in the direction of water flow and staple. Place blankets in a minimum of three rows wide (4-ft. each for a total width of 12-ft.) within the drainage swale/ditch and staple together in accordance with manufacturer's instructions. Overlap blanket side edges a minimum of 4-in.

C. To secure the blankets, install staples made of wire, 0.091-in. in diameter or greater, "U" shaped with legs 10-in. in length, and with a 1½-in. crown. Commercial biodegradable stakes may also be used with prior approval by the Engineer. Drive the staples vertically into the ground, spaced approximately two (2) linear feet apart, on each side of the blanket, and one (1) row in the center alternately spaced between each side.

D. Bury the upper and lower ends of the matting to a depth of 4-in. in a trench. Create erosion stops every 25-ft. by making a fold in the fabric and carrying the fold into a slit trench across the full width of the blanket. The bottom of the fold shall be 4-in. below the ground surface. Staple on both sides of the fold.

E. Where the matting must be cut or more than one roll length is required in the swale, turn down upper end of downstream roll into a slit trench to a depth of 4-in. Overlap the lower end of the upstream roll 4-in. past the edge of the downstream roll and staple.

F. To ensure full contact with soil surface, roll matting with a roller weighing 100 lbs./ft. of width perpendicular to flow direction after seeding, mat placement, and stapling. Thoroughly inspect channel after completion. Correct any areas where matting does not present a smooth surface in full contact with the soil below.

3.06 SPILL PREVENTION

A. In the event that spills occur that are the direct result of the Contractor's actions or negligence, the clean up and reporting of the spill shall be performed by the Contractor at no cost to the Owner.
   1. Petroleum Products: Monitor all on-site vehicles for leaks and provide regular preventative maintenance to vehicles and equipment to reduce the chance of petroleum leakage on the project site. Store petroleum products in tightly sealed containers that are clearly labeled. Apply all asphalt substances according to the manufacturer's recommendations and/or these specifications.

   2. Fertilizers: Apply fertilizers only in the manner and amounts required by the specifications. Store materials in a covered area and do not expose to precipitation. Remove and dispose of partially used fertilizer bags properly.

   3. Paints and Solvents: Store all paint and solvent in tightly sealed containers when not required for use. Remove and dispose of excess material and waste according to the manufacturer's instructions and/or State and Federal Regulations.

   4. Concrete Trucks: Direct concrete trucks to discharge surplus concrete or drum wash water on site only in concrete washout areas designated on the construction plans or SWP3.

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5. Concrete Curing Agents: Apply concrete curing agents only in the manner and amount required by the specifications. Do not allow excess material to run off the areas being treated.

6. Off-site Sediment Control: Minimize off-site sediment transportation by limiting vehicle tracking and dust generation. The development and implementation of a dust control plan and off-site vehicle tracking plan will be the responsibility of the Contractor.

## 3.07 REMOVAL AND FINAL CLEANUP

A. Once the site has been fully stabilized against erosion, remove sediment control devices and all accumulated silt. Dispose of silt and waste materials in a proper manner. Regrade all areas disturbed during this process and stabilize against erosion with surfacing materials as indicated on the Drawings.

B. Provide written notice to the Owner that the site has been stabilized in accordance with the SWP3 and the General Permit prior to removing temporary sediment control devices.

## 3.08 MAINTENANCE, REMOVAL AND RESTORATION

A. Maintain all pollution control measures and works in a functional condition as long as needed during the construction operation. Remove all temporary measures and restore the site to as nearly original conditions as practicable.

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SECTION 02515

CONCRETE WALKWAYS

PART 1: GENERAL

1.01 SCOPE OF WORK

A. Furnish all labor, materials, equipment and incidentals required and install concrete walkways, pads and pond aprons as shown on the Drawings and as specified herein.

1.02 RELATED WORK

A. Earthwork is included in Section 02200.

B. Loaming and hydroseeding is included in Section 02930.

1.03 SUBMITTALS

1.04 REFERENCE STANDARDS

A. American Society for Testing and Materials (ASTM)

1. ASTM A185 - Standard Specification for Steel Welded Wire Fabric, Plain, for Concrete Reinforcement.

B. American Association of State Highway and Transportation Officials (AASHTO)

1. AASHTO M213 - Standard Specification for Preformed Expansion Joint Fillers for Concrete Paving and Structural Construction (Non-extruding and Resilient Bituminous Types)

C. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

PART 2: PRODUCTS

2.01 MATERIALS

A. Concrete shall be as specified in Section (03 30 00) (03300), but in no case less than 3,500 psi at 28 days.

B. Welded wire fabric shall conform to ASTM A185 and shall be of size and gauge shown.

C. Expansion joint filler shall be bituminous type, 1/2-in. thick meeting AASHTO M-213-65.

D. Materials for gravel base course shall be as specified in Section 02230.

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PART 3: EXECUTION

3.01 INSTALLATION

A. The subgrade for walkways shall be shaped parallel to the proposed surface of the walkways and thoroughly compacted. All depressions occurring shall be filled and again compacted until the surface is smooth and hard.

B. After the subgrade has been prepared, a gravel base course shall be placed. After being thoroughly compacted, the base course shall be at least 8-in. in thickness and parallel to the proposed surface of the walkway.

C. Forms

1. Side and transverse forms shall be smooth, free from warp, of sufficient strength to resist springing out of shape, of a depth to conform to the thickness of the walkway and of a type satisfactory to the Engineer.

2. All mortar or dirt shall be completely removed from forms that have been previously used. The forms shall be well staked and thoroughly braced and set to the established lines with their upper edge conforming to the grade of the finished walk which shall have sufficient pitch to provide for surface drainage, but not to exceed 1/4-in/ft.

3. All forms shall be oiled as specified in Section 03300 before placing concrete.

D. Wire Fabric Reinforcement

1. All wire fabric shall be stored off the ground and shall be protected from moisture and be kept free from dirt, oil, or injurious coatings.

2. Splices in welded wire fabric shall be lapped not less than 1-1/2 courses or 12-in., whichever is greater. Wire fabric splices shall be tied together with wire ties as approved spaced no more than 24-in. on center. Support as approved in middle of slab.

3. Before being placed in position, wire fabric shall be thoroughly cleaned of loose mill and rust scale, dirt and other coatings, including ice, that reduce or destroy bond. Where there is delay in depositing concrete after reinforcement is in place, fabric shall be reinspected and cleaned when necessary.

4. In no case shall wire fabric be covered with concrete until the amount and position of the fabric have been checked by the Engineer and his/her permission given to proceed with the concreting.

E. Placing and Finishing Concrete

1. Concrete walkways shall be placed in alternate slabs not exceeding 30-ft in length, except as otherwise ordered. The slabs shall be separated by transverse, preformed expansion joint filler.
2. Preformed expansion joint filler shall be placed adjacent to structures as directed.

3. Concrete shall be placed in such quantity that, after being thoroughly consolidated in place, it shall be 4-in. in depth. Finishing operations shall be delayed until all bled water

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and water sheen has left the surface and concrete has started to stiffen. After water sheen has disappeared, edging operations shall be completed. After edging and jointing operations, the surface shall be floated with an aluminum or magnesium float. Immediately following floating, the surface shall be steel troweled. If necessary, tooled joints and edges shall be rerun before and after troweling to maintain uniformity. Finish with broom at right angles to alignment of walk, then round all edges with 1/4-in. radius after brooming.

4. When completed, the walkways shall be kept moist and protected from traffic and weather for at least 3 days.

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SECTION 02575

# ROADWAYS, MARKINGS, GUARD RAILS AND APPURTENANCES

## PART 1 GENERAL

### 1.01 SCOPE OF WORK

A. Furnish all labor, materials, equipment and incidentals required and install the bituminous paved roadway, pavement markings, parking areas, curbing and guard rails as shown on the Drawings and as specified herein.

### 1.02 RELATED WORK

A. Site preparation is included in Section 02100.

B. Trenching, backfilling and compaction is included in Section 02221.

C. Granular fill material is included in Section 02230.

D. Loaming, hydroseeding and erosion control is included in Section 02930.

### 1.03 SUBMITTALS

A. Submit, in accordance with Section 01300, shop drawings showing dimensions layouts and details of construction and accessories required.

B. Submit composition limits of job mix formula for aggregate sizes in bituminous concrete.

### 1.04 REFERENCE STANDARDS

A. Except as otherwise specified herein, the material and construction shall be in accordance with the Arkansas Highway, Standard Specifications for Highways and Bridges of the State of Arkansas, latest edition, including all addenda -SSHB.

B. American Society for Testing and Materials (ASTM)

1. ASTM A307 - Standard Specification for Carbon Steel Bolts and Studs 60,000 psi Tensile Strength.

2. ASTM A242 - Standard Specification for High-Strength Low-Alloy Structural Steel (not galvanized, corrosion resistant, unpainted).

C. American Association of State Highway and Transportation Officials (AASHTO)

1. AASHTO M144 - Standard Specification for Calcium Chloride

2. AASHTO M180 - Standard Specification for Corrugated Sheet Steel Beams for Highway Guardrail.

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D. American Wood Preservers Association (AWPA)

1. AWPA C1 - All Timber Products, Preservative Treatment by Pressure Processes

2. AWPA C14 - Wood for Highway Construction, Pressure Treatment

3. AWPA M4 - Care of Pressure-Treated Wood Products.

4. AWPA P5 - Waterborne Preservatives.

E. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

PART 2 PRODUCTS

2.01 MATERIALS

A. Bituminous Concrete Paving shall be Class I, as specified in [Sections 460 and M3.11.0] of the above referenced standards.

B. Calcium chloride shall meet AASHTO M-144 and shall be spread wherever directed to allay dust conditions. The Engineer may direct the Contractor to employ sprinkling of water in lieu of calcium chloride for dust control.

C. Guard Rails shall be of the type and size as shown on the Drawings.

1. The steel guardrail shall conform to the requirements of AASHTO M180, 0.105-in thick, W beam shape and be fabricated of corrosion resistant steel. Beams of corrosion resistant steel shall not be painted or galvanized. They shall be handled and stored so that the traffic face of these beams shall not show a distinctive color differential. End or buffer sections shall be of the same or greater thickness of metal and shall be of the same type of corrosion resistant steel. Only drilling or cutting necessary for special connections and for sampling will be permitted in the field. Warped or deformed beams will be rejected and beams erected on a radius of 150-ft or less shall be shop curved to the appropriate curvature.

2. All connections or splices shall be formed with oval shoulder button head bolts and washers to minimize projections on the road side of the guardrail. Unless otherwise specified, bolts and nuts shall conform to or exceed requirements of ASTM A307 and shall be of an approved corrosion resistant material.

3. Wood posts shall be southern yellow pine, seasoned pressure treated, as specified herein. Posts shall be rectangular in Section, 6-in by 8-in with tops sloped 3/8-in from front to back and square butt, select structural grade, surfaced four sides (S4S) and shall conform to the requirements of the "Standard Grading Rules for Southern Yellow Pine" of the Southern Products Association. All timber shall be pressure treated with "Osmose K-33" (chromated copper arsenate) which meets AWPA standard P-5 and Federal Specification TT-W-550-Type II in accordance with AWPA Standards C1 and C14. Minimum retention of preservative shall be 0.50 lbs/sq ft. Posts shall be free of shakes, excessive checking and other structurally weakening defects. No unnecessary cutting of treated

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posts will be allowed after treatment and all posts whose surfaces have been damaged by cutting, drilling or other causes shall be field treated with a preservative solution in accordance with AWPA Standard M4. The above grade portions of all posts shall be painted with two coats of dark brown Olympic Semi-Transparent oil stain.

4. Reflectors in the form of guardrail inserts shall be installed at 100-ft intervals at a post location and be visible from both directions of movement. Barrier guardrail delineators shall be white, UV resistant acrylic plastic inserts with two-way reflection by Stimsonite Corp., Niles, IL or equal.

D. Road markers shall be placed where no guardrail exists along both sides of the access roadway at 200-ft intervals as approved by the Engineer. Road marker reflectors shall be 62-in long brown Carsonite road marker CRM-375 with white Hi-intensity grade reflective sheeting 8-in in length on two sides and be manufactured by Carsonite International, Carson City, NV or equal.

E. Asphalt - Tack coat shall consist of either emulsified asphalt, grade RS-1 conforming to [Section M3.03.0], or cutback asphalt, grade RC-70 or RC-250 conforming to [Section M3.02.0] of the above referenced standards.

F. Pavement marking paint shall be fast drying type (P-226) conforming to [Section M7.01.11 of] the above referenced standards.

G. Gravel Subbase (bank-run gravel) shall be as specified in Section 02221.

## PART 3 EXECUTION

### 3.01 PAVING - GENERAL

A. Bituminous concrete pavement shall be installed in accordance with [Section 460 of SSHB and] the following specifications.

B. The binder course shall be placed as soon as possible after the 12-in gravel subbase has been prepared, shaped and compacted.

C. The binder course shall be placed and compacted by steel-wheeled rollers of sufficient weight to thoroughly compact the bituminous concrete. Where necessary, the new pavement shall be rolled smooth and even with the existing pavement.

D. Maintain pavement under this Contract during the guarantee period of 1 year and promptly (within 3 days of notice given by Engineer or Owner) refill and repave areas which have settled or are otherwise unsatisfactory for traffic.

E. All pavement thicknesses referred to herein are compacted thicknesses. Place sufficient mix to ensure that the specified thickness of pavement occurs wherever called for.

F. When required, remove existing pavement by saw, pneumatic hammer or wheel, cutting edges of trenches to be repaved as directed by the Engineer. After pipe laying, backfilling and compaction operations are completed satisfactorily and after the gravel subbase is shaped and compacted, place the type of pavement as directed by the Engineer.

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G. Hose clean all road surfaces after backfilling and before any surfacing, but in no case will pavement be placed until the gravel base is dry and compacted to at least 95 percent maximum density at optimum moisture content.

H. All manhole frames and utility boxes are to be set to the grade of the wearing course. At no time shall the manhole frames be allowed to protrude above the surface of the wearing course.

I. Furnish and spread calcium chloride on disturbed surfaces to allay dust conditions as directed by the Engineer and in accordance with the requirements established by Section 01562.

J. The contact surfaces of castings and other structures shall be painted with a tack coat.

K. After the paving mixture has been properly spread, initial compaction shall be obtained by the use of power rollers weighing not less than 240 lbs/in width of tread.

L. Final compaction of the surface shall be accomplished by rollers weighing not less than 285 lbs/in width of tread. Along curbs, structures and all places not accessible with a roller, the mixture shall be thoroughly compacted with tampers. Such tampers shall not weigh less than 25 lbs and shall have a tamping face of not more than 50 sq in. The surface of the mixture after compaction shall be smooth and true to the established line and grade.

M. When the air temperature falls below 50 degrees F, extra precautions shall be taken in drying the aggregates, controlling the temperatures of the materials and placing and compacting the mixtures.

N. No mixtures shall be placed when the air temperature is below 40 degrees F, nor when the material on which the mixtures are to be placed contains frost or has a surface temperature the Engineer considers too low.

O. No vehicular traffic or loads shall be permitted on the newly completed pavement until adequate stability has been attained and the material has cooled sufficiently to prevent distortion or loss of fines. If the climatic or other conditions warrant it, the period of time before opening to traffic may be extended at the discretion of the Engineer.

## 3.02 TRENCH PAVEMENT RESTORATION

A. Place 2-1/2-in binder course over trenches cut in existing paved areas no later than 1 week after the trench has been backfilled. The paving shall be maintained until overlaid with a 1-1/2-in wearing course.

B. If points of settlement or holes appear in the pavement, repair the same within 3 days of notification by the Engineer or Owner. If after due notice, if failure to make the repairs is evident, the work will be done by the Owner and the total cost of such repairs will be charged to the Contractor.

## 3.03 GUARD RAILS

A. Guard rails and posts shall be installed at the locations and according to the details shown on the Drawings and as specified [in Section 601 of SSHB and] herein.

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B. Reflectors shall be installed on the guardrails in accordance with manufacturer's instructions.

3.04 ROAD MARKERS

A. Road markers shall be installed in accordance with the manufacturer's instructions.

B. Road marker locations shall be spotted in the field and approved by the Engineer before installation.

3.05 ROADWAY MARKINGS

A. Markings shall be located as follows:

1. Parking area as shown on the Drawings.

B. All surface dirt within the areas to be painted shall be removed. Large areas of tar, grease or foreign materials may require sand blasting, steam cleaning or power brooming to accomplish complete removal. Application of stripes shall not proceed until final authorization is received from the Engineer.

C. Markings shall be fast drying white water-borne traffic paint as follows:

| Material | Material Application Temperature | Line Thickness | Reflectorized Bead Application |
|---|---|---|---|
| [M7.01.23] | 40 to 120 degrees F | 15 mils | 6 lbs/gal |

D. No thinners shall be used for the above listed pavement marking applications except in accordance with the manufacturer's specifications and at the direction of the Engineer.

E. No paint or pavement marking material shall be heated above the temperature marked on the container.

F. Bituminous concrete pavements shall have been in place for 48 hours prior to the application of pavement markings.

G. If for any reason material is spilled or tracked on the pavement, or any markings applied, in the Engineer's judgment, fail to conform because of a deviation from the desired pattern, remove such material by a method that is not injurious to the roadway surface and is acceptable to the Engineer, clean the roadway surface and prepare the surface for a reapplication of markings and reapply the markings as directed without additional compensation for any of the foregoing corrective operations.

END OF SECTION

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SECTION 02577

ASPHALTIC CONCRETE PAVING

PART 1 GENERAL

1.01 SCOPE OF WORK

A. Section Includes:

1. Asphaltic concrete pavement for roadways, parking areas, ramps, grade adjustments and walkways on prepared aggregate base course or subgrade as shown on the Drawings.

2. Removal, preparation and replacement of existing asphaltic concrete pavement required for the construction of buried utilities, new structures, or potholing that is part of the Work.

3. Removal, preparation, and replacement or repair of existing asphaltic concrete pavement that is damaged by Contractor's operations during the construction of the Work.

4. Temporary asphaltic concrete pavements until the permanent pavements can be constructed.

1.02 RELATED WORK

A. Earthwork is included in Section 02200.

B. Aggregate Base Course is included in Section 02220.

C. Painted Traffic Lines and Markings are included in Section 02575.

1.03 SUBMITTALS

A. Submit, in accordance with Section 01300, the following:

1. Product information for aggregate materials, asphaltic concrete mix design, and prime and tack coats. Minimum information shall include source of aggregates and asphalt, gradation, unit weight of mix design, gradation, air void content, and other test results needed for comparison with Local Building Code and field testing by Engineer.

1.04 REFERENCE STANDARDS

A. State of Arkansas Department of Transportation:

1. Standard Specifications.

B. American Society for Testing and Materials (ASTM):

1. ASTM D1557 - Test Methods for Moisture-Density Relations of Soils and Soil Aggregate Mixtures Using 10-lb Rammer and 18-in Drop.

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2. ASTM D5581 - Test Method for Resistance to Plastic Flow of Bituminous Mixtures Using Marshall Apparatus.

## PART 2 PRODUCTS

### 2.01 MATERIALS

A. Prime (tack) coat shall be Type SC-70 liquid asphalt conforming to the requirements of the Local Building Code.

B. Asphaltic concrete surfacing for roadways, parking areas, ramps, grade adjustments, and walkways shall conform to the requirements of the Local Building Code. Mineral aggregate shall be 1/2-in maximum size, medium; Type B.

C. Asphalt to be mixed with the aggregate shall meet the requirements of the Local Building Code, steam-refined paving asphalt.

D. Asphalt or asphaltic concrete component quantities not defined herein or specifically defined in the Local Building Code shall be those typically used for high quality pavement products.

## PART 3 EXECUTION

### 3.01 CUTTING PAVEMENT

A. Existing asphaltic pavements to be removed shall be cut by a wheel cutter, clay spade, or other device capable of making a neat, reasonably straight and smooth cut without damaging adjacent pavement that is not to be removed.

B. The existing pavement shall be saw cut and trimmed after placement of required base course material and just prior to placement of asphaltic concrete for pavement replacement, and the trimmed edges shall be painted with a coating of prime coat immediately prior to constructing the new abutting asphaltic pavements. No extra payment shall be provided for these items, and all costs incurred in performing this work shall be incidental to underground utility construction or pavement replacement.

C. All removed asphaltic pavement material is the property and disposal responsibility of the Contractor.

### 3.02 PAVEMENT INSTALLATION

A. The construction of pavements of asphaltic concrete shall conform to the requirements of the Local Building Code and upon completion the pavement shall be true to grade and cross sections.

B. The Contractor shall not pass equipment over any pipe, drain, utility line, duct or structure before it is protected by ample fill material, properly compacted. Any damage to such facilities shall be promptly repaired by the Contractor at its own expense.

C. The subgrade shall be brought to the required grades and cross sections by excavating, filling, blading and compacting as specified.

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D. Asphaltic concrete shall be constructed only when the surface is dry, when the atmospheric temperature in the shade is 40 degrees F (4 degrees C) and rising or above 50 degrees F (10 degrees C) if falling. No asphaltic concrete shall be placed when the weather is foggy or rainy or when the base on which the material is to be placed is in a wet or frozen condition.

E. Base and subbase materials shall be bladed to a smooth surface and shall be compacted to 95 percent relative compaction as determined by ASTM D1557. Subgrade for pavement shall not vary more than 0.05 feet (1.5 cm) from the specified road grade.

F. Asphaltic concrete shall be plant mix having a minimum overall thickness of 3-in unless greater thicknesses are shown on the Drawings. Compact the asphaltic concrete to at least 95 percent of the relative compaction achieved by a specimen of the same mix design subjected to 75 blows per ASTM D5561.

G. All existing asphaltic pavement to be paved over or against shall receive a tack coat at a rate of 0.1 gallons per square yard (0.46 liters per square meter).

H. The total width of the accepted aggregate base material shall receive a bituminous prime coat at the rate of 0.25 gallons per square yard (1.14 liters per square meter). Application shall conform to the Local Building Code. Adjacent ground, structures, curbing, and fencing shall be protected from spraying operations.

I. When asphaltic concrete is to be applied over existing pavement and local irregularities (with only very minor damage) in the existing surface would result in a course of more than specified thickness, the surface of the existing pavement shall be brought to uniform contour by patching with asphaltic concrete, thoroughly tamped or rolled until it conforms with the surrounding surface, and a prime coat applied.

J. When asphaltic concrete is to be applied over existing pavement, existing surfaces adjoining gutters and other permanent features shall be ground to create smooth transitions and to maintain surface water flow lines.

K. Potholes and depressed areas in existing pavements to be overlaid with new asphaltic concrete shall be saw cut and completely removed, subgrade and aggregate base course prepared, and patched with new asphaltic concrete before the installation of new pavement overlays.

L. Spreading shall be as nearly continuous as possible. When asphaltic concrete is laid against vertical surfaces such as gutters, the face of the vertical surface shall be roughened for proper bonding, cleaned, and then painted with a light coating of asphalt cement or emulsified asphalt.

M. At terminations of new surface course, the asphaltic concrete shall be feathered into the existing surface over such a distance as may be required to produce a smooth riding transition. Existing pavements to be over-laid shall be ground or removed as required to avoid feather edges less than 1-in in depth.

N. Grind all edges with concrete swales and gutters to provide minimum 1-in depth at transition and to maintain original drainage flow lines between new and existing surfacing unless otherwise noted.

O. The finished surface shall be of uniform texture. When tested with a 10-ft straightedge laid on the surface parallel with the centerline of the road, the variation of the surface from the testing edge of the straightedge shall not be more than 1/4-in. except at grade changes.

P. The top of pavement shall match utility surface features such as valve boxes, corrosion protection test station boxes, electrical and telephone pull boxes, utility vaults, etc. Wherever possible drainage should be directed away from such utility structures, except drainage structures such as curb inlets and drop inlets.

## 3.03 ROADWAY SURFACE REMOVAL

A. All pavement cuts shall be neat and straight to provide an unfractured and level pavement joint for bonding existing surfacing with pavement replacement. Pavement cuts shall be parallel or at right angles to the road or area centerlines. All cut edges shall provide clean, solid, vertical faces free from all loose material.

B. All existing crushed aggregate and asphaltic concrete removed, and any excess new material shall be hauled away from the project site and legally disposed of by the Contractor.

## 3.04 RESURFACING

A. In all existing pavement areas where the surface is removed, broken or damaged by Contractor's equipment or in which the ground has caved in or settled due to the installation of the improvements, or areas designated to be repaved, resurfaced, or modified, the surface shall be restored to the original grade by the Contractor. Prior to resurfacing, the existing surfacing shall be removed as provided above. All broken and jagged edges of the pavement edge shall be straight. Areas to be cut shall be indicated until these edges have been sawed. If during the initial removal of the existing pavement a method of removal was used which disturbed the adjoining pavement, or if during general construction operations the adjacent pavement was disturbed, then this adjoining pavement must also be removed and replaced. Where irregular surfaces are to be surfaced, existing pavement shall be cut parallel to the alignment of the pipe or to the centerline of the roadway. Asphaltic concrete pavement shall be saw cut to a minimum depth of 2-in at a point not less than 6-in outside the limits of excavation or the previous pavement cut (made by pneumatic tools), whichever limits are the greater. The additional surfacing so cut shall be removed and disposed of by the Contractor prior to resurfacing.

B. Restoration of asphaltic concrete pavement shall be to the same section as the existing roadway/paved area or a minimum thickness of 2-in, whichever is greater.

C. Wherever asphaltic concrete pavement does not terminate against a curb, gutter, or another pavement, the Contractor shall provide and install a ground contact rated, pressure treated hem-fir, No. 2 or better, 2 by 6 header board, securely staked and fastened in place.

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3.05 PAVEMENT MARKING REPAIR

A. All traffic markings and signs painted on areas which are covered with new or repair pavement shall be replaced in kind. See Section 32 17 23.

3.06 ASPHALT CONCRETE DIKES

A. Asphalt concrete dikes shall be hot mix, machine-laid, extruded to the section shown on the Drawings. Dikes shall be constructed of asphalt concrete conforming to Local Building Code. Grading of the mix shall meet the approval of the Engineer. Dikes shall be stable with low (5 to 10 percent) air void content.

3.07 SPECIAL REQUIREMENTS

A. The restoration of all surfaces, as described herein, disturbed by the installation or repair to underground facilities shall be completed as soon as is reasonable and practical.

B. Areas trenched by the Contractor and designated to be resurfaced shall be temporarily paved with 1-in thick (minimum) layer of cold asphalt mix within 3 working days after they are backfilled. After all major work that might damage pavement is completed, and complete resurfacing of the entire specified area shall be performed.

3.08 CLEAN-UP

A. After all installation, repair and restoration of paving has been completed, all excess asphalt, dirt, rock and other debris shall be removed from the roadways. Adjoining curbs, gutters, structures, and other surfaces over-sprayed or splattered shall be cleaned of all asphalt concrete products.

3.09 REPAIR OF PAVEMENT SURFACE

A. Following Final Completion, the Contractor shall repair settled pavement over trenches, excavation, or backfill placed as part of this Work during the period of the warranty of the Work.

B. All materials and labor required for the repair of paving shall be supplied by the Contractor and the work shall be done in a manner satisfactory to the Engineer.

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SECTION 02616

# DUCTILE IRON PIPE AND FITTINGS

## PART 1 GENERAL

### 1.01 SCOPE OF WORK

A. Furnish all labor, materials, equipment and incidentals required, install, disinfect and test ductile iron pipe and fittings for yard piping as shown on the Drawings and as specified herein.

B. Yard piping shall include all piping and fittings extending outward, upward and downward into the ground from the outside face of all buildings. Unless otherwise noted, non-buried pipe outside a building, including in utility tunnels, shall be specified in Division 15. Yard piping shall begin at the outside face of the buildings. The first joint shall be not more than 2-ft from the outside face of the building or structure unless otherwise shown on the Drawings. Yard piping shall include all piping in valve vaults, manholes, cleanouts and similar yard structures.

C. Piping shall be located substantially as shown on the Drawings. The Engineer reserves the right to make such modifications in locations as may be found desirable to avoid interference between pipes or for other reasons. Pipe fitting notation is for the Contractor's convenience and does not relieve him/her from installing and jointing different or additional items where required to achieve a complete piping system.

D. Where the word "pipe" is used it shall refer to pipe, fittings, or appurtenances unless otherwise noted.

E. The existing yard piping shown on the Drawings is based to a large degree on interpolations from record drawings. Neither the Owner nor the Engineer make any guarantees as to the correctness or completeness of these Drawings. The Contractor shall field locate all existing yard piping. Pipe locations or conditions found to differ from the Contract Drawings will not be considered as sole justification for a change in the Contract Price.

### 1.02 RELATED WORK

A. Delivery, Storage and Handling is included in Section 01600.

B. Trenching, Backfilling and Compaction is included in Section 02221.

C. Sedimentation and Erosion Control is included in Section 02270.

D. Pavement Repair and Resurfacing is included in Section 02501.

E. Valves, Hydrants and Appurtenances are included in Section 02640.

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1.03 SUBMITTALS

A. Submit shop drawings and product data, including piping layouts, design calculations, warranty information, test reports, in accordance with Section 01300 and the referenced standards.

B. Submit the name of the pipe and fitting suppliers and a list of materials to be furnished.

C. Prior to shipment of pipe, certified copies of mill tests confirming the type of materials used in the pipe, and shop testing of pipe to show compliance with the requirements of the applicable standards, along with a sworn affidavit of compliance that the pipe complies with the referenced standards, shall be submitted.

D. Submit copies of all shop tests, including hydrostatic tests.

E. Submit information on all warranties per Section 01740.

F. Submit anticipated production and delivery schedule.

G. Prior to shipment of pipe, submit a certified affidavit of compliance from the manufacturer stating that the pipe, fittings, gaskets, linings and exterior coatings for this project have been manufactured and tested in accordance with AWWA and ASTM standards and requirements specified herein.

H. Submit handling procedures for all phases from finished fabrication through delivery including storage, transportation, loading, and unloading. This will include storage at the project site and required protection following installation prior to startup.

I. Submit shop drawings with a tabulated laying schedule which references stations and invert elevations as shown on the Drawings as well as all fittings, bends, outlets, restrained joints, tees, special deflection bells, adapters, solid sleeves and specials, along with the manufacturer's drawings and specifications providing complete details of all items. The laying schedule shall show pipe class, class coding, station limits and transition stations for various pipe classes. The above shall be submitted to the Engineer for approval before manufacture and shipment. The location of all pipes shall conform to the locations indicated on the Drawings. Full length pipe may be supplied from inventory provided that all specification requirements are met. Shop drawings shall include but not be limited to:

1. Complete and dimensional working drawings of all pipe layouts, including pipe stationing, invert elevation at changes in grade or horizontal alignment, all elements of curves and bends both in horizontal alignment and vertical position.

2. The grade of material; size, wall thickness, of the pipe and fittings and appurtenances, type and location of fittings, specials, and valves; and the type and limits of the lining, lining reinforcing and coating systems of the pipe and fittings. Methods and procedures recommended by the coating manufacturer will be documented.

3. Joint details; methods and locations of supports,; and complete information concerning type, size and location of all welds. Shop welds (no field welding will be allowed) will be clearly differentiated and welds will be clearly detailed with preparation procedures for all

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pipe and parent material comprising each weld. Critical welding procedures will be identified along with methods for controlling welding stresses and distortions. Locations and proposed joint details will also be clearly identified.

4. Method of manufacture of pipe; joint details; fittings; and any specials.

5. All other pertinent information for all items to be furnished; product data to show compliance of all couplings, supports, fittings, coatings and related items.

1.04 REFERENCE STANDARDS

A. American Society for Testing and Materials (ASTM)

1. ASTM A193 - Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service.

2. ASTM A194 - Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High-Pressure and High-Temperature Service.

3. ASTM A674 – Standard Practice for Polyethylene Encasement for Ductile Iron Pipe for Water or Other Liquids.

4. ASTM A746 - Standard Specification for Ductile Iron Gravity Sewer Pipe.

B. American Water Works Association (AWWA)

1. AWWA C104 - Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water.

2. AWWA C105 - Polyethylene Encasement for Ductile-Iron Pipe Systems.

3. AWWA C110 - Ductile-Iron and Gray-Iron Fittings, 3-in through 48-in (75mm Through 1219mm) for Water.

4. AWWA C111 - Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.

5. AWWA C150 - Thickness Design of Ductile-Iron Pipe.

6. AWWA C151 - Ductile-Iron Pipe, Centrifugally Cast, for Water.

7. AWWA C116 – Protective Fusion-Bonded Epoxy Coatings for the Interior and Exterior surfaces of Ductile Iron and Grey Iron Fittings for Water Supply Service.

8. AWWA C153 - Ductile- Iron Compact Fittings, 3-in through 24-in and 54-in through 64-in, for Water.

9. AWWA C550 – Protective Interior Coatings for Valves and Hydrants

10. AWWA C600 - Installation of Ductile-Iron Water Mains and Their Appurtenances.

11. AWWA C606 - Grooved and Shouldered Joints.

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12. AWWA C651 - Disinfecting Water Mains.

13. AWWA M41 – Ductile Iron Pipe and Fittings Manual of Water Supply Practices

C. National Sanitation Foundation (NSF)

1. NSF 61 – Drinking Water System Components Health Effects.

D. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.05 QUALITY ASSURANCE

A. Ductile iron pipe and fittings under this Section may be designed and supplied by multiple qualified manufactures to meet supply requirements. Coordination of design and submittal requirements for consistency will be the Contractor's sole responsibility.

B. Each length of ductile iron pipe supplied for the project shall be hydrostatically tested at the point of manufacture to 500 psi for a duration of 10 seconds per AWWA C151. Testing may be performed prior to machining bell and spigot. Failure of ductile iron pipe shall be defined as any leak or rupture of the pipe wall. Certified test results shall be furnished in duplicate to the Engineer prior to time of shipment.

C. All ductile-iron pipe and fittings to be installed under this project shall be inspected and tested at the foundry as required by the standard specifications to which the material is manufactured.

D. Inspection of the pipe and fittings will also be made by the Engineer or representative of the Owner after delivery. The pipe shall be subject to rejection at any time on account of failure to meet any of the Specification requirements even though pipe may have been accepted as satisfactory at the place of manufacture. Pipe rejected after delivery (including defects from manufacturing or delivery/transport) shall be marked for identification and shall immediately be removed from the job at the Contractor's expense.

E. The manufacturer shall meet the following criteria and furnish the necessary project information , which demonstrates the required experience:

1. Experience that includes successful fabrication (followed by installation, acceptance and service) to AWWA C151 standards of at least [50,000] lineal feet of the largest specified diameter or larger ductile iron pipe with similar linings/coatings within the past 5 years.

2. Experience shall include the successful fabrication of at least 50- fittings in compliance with AWWA C110 or C153 of the largest specified diameter or larger with similar lining/coatings within the past 5 years.

3. Experience that includes the successful fabrication (followed by installation, acceptance and service) of at least 10,000 lineal feet of the largest specified diameter or larger push-on style, boltless restrained joint for ductile iron pipe within the last 5 years.

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F. All pipe and fittings shall be marked in accordance with all applicable AWWA standards. Legibly and permanently mark all pipe, fittings, specials and appurtenances to be consistent with the laying schedule and marking drawings (if required) with the following information:

1. Manufacturer, date.

2. Size, type, class, or wall thickness.

3. AWWA Standard(s) produced to.

G. The Owner may elect to hire an independent testing laboratory, at the Owner's expense, to inspect all pipe and fittings at the foundry for compliance with these specifications.

1.06 DESCRIPTION OF SYSTEMS

A. Pipe shall be made in the United States. Fittings may be made outside the United States, but shall be supplied by one of the named pipe manufacturers or engineer approved equal. Pipe and fittings shall be as supplied by the American Cast Iron Pipe Co., U.S. Pipe and Foundry, Griffin Pipe Products, all pipe divisions of the McWane Company or an approved equal who is a member of the Ductile Iron Pipe Research Association (DIPRA). The fittings supplier shall certify in writing that their fittings are compatible with the supplied brand of pipe.

B. Pipe is to be installed in those locations shown on the Drawings, and only where specifically indicated.

C. Contractor is responsible for compatibility between joints of all items they supply.

1.07 DELIVERY, STORAGE AND HANDLING

A. Care shall be taken in loading, transporting, and unloading to prevent injury to the pipe, pipe linings and pipe coatings. See AWWA C600 and the referenced AWWA Standards for Shipping, handling and storage procedures. All pipe and fittings shall be examined as noted in Division 1. Any damage to linings or coatings discovered during the examination shall be repaired to the satisfaction of the Engineer at the cost of the Contractor, before proceeding with the work.

B. Pipe shall be transported to the job site on padded bunks or oak timbers and secured with steel banding or nylon tie down straps to adequately protect the pipe and coating. Slings, hooks, or pipe tongs or other devices acceptable to the Engineer shall be used in pipe handling. No uncushioned ropes, chairs, wedges, cables or levers shall be used in handling finished pipe, fittings or couplings. Under no circumstances shall the pipe or fittings be dropped or skidded against each other. Care shall be taken to preventing marring the pipe coating. Padded wooden pipe cradles, or chocks suitable for the protection of coatings shall be used between finished pipes and beneath them when pipes are placed upon rough surfaces. Pipe shall not be stored on bare ground unless soft sand berms are used to support the pipe and is approved by the Engineer.

C. Materials, if stored, shall be kept safe from damage. The interior of all pipe, fittings and other appurtenances shall be kept free from dirt, excessive corrosion or foreign matter at all times.

D. Pipe shall not be stacked higher than the limits recommended by its manufacturer. The bottom tier shall be kept off the ground on timbers, rails, or concrete. Stacking shall conform to manufacturer's recommendations and/or AWWA C600.

E. Gaskets for mechanical and push-on joints to be stored shall be placed in a cool location out of direct sunlight. Gaskets shall not come in contact with petroleum products. Gaskets shall be used on a first-in, first-out basis.

F. Lined and/or coated pipe shall be suitably protected from exposure and heating of the sun at all times following procedures recommended by the coating/lining system manufacturer. Exposure will not be allowed (except for short periods such as installation, assembly and repairs).

G. No metal tools or heavy objects shall be permitted to come in contact unnecessarily with the finished coating. Workers will be permitted to walk upon the coated pipe only when necessary, in which case they shall wear footwear with rubber or composition soles and heels that are sufficiently free of dirt and mud that coating remains undamaged.

H. It shall be the responsibility of the Contractor to prevent damage to the linings and coatings that might be caused by handling and/or onsite storage of the finished pipe at low temperatures (due to embrittlement), high temperatures or direct sunlight.

1.08 Warranties

A. Provide warranties as required in Section 01740.

PART 2 PRODUCTS

2.01 GENERAL

A. All gravity and pressurized piping installed to convey primary effluent (PE), return activated sludge (RAS), waste activated sludge (WAS), scum (SSC), secondary clarifier effluent (SCE), and mixed liquor (ML) shall be constructed of ductile iron pipe with Protecto 401 lining or SP2000 by Fast Fabricators and bituminous exterior coating, conforming to AWWA C104, C111, C150 and C151.

B. Unless otherwise indicated, water distribution (potable and process water) and force main (pressurized) piping shall be constructed of ductile iron pipe with restrained joint fittings, cement lining, and bituminous exterior coating, conforming to AWWA C104, C111, C150 and C151.

C. Water distribution and force main piping shall be constructed with one of the following methods:

1. Unrestrained push-on joint pipe, similar and equal to Fastite Joint Pipe, by American Ductile Iron Pipe, with restrained push-on joint or restrained mechanical joint fittings and concrete thrust blocking. Fittings shall be standard or compact size conforming to AWWA C110 or C153, respectively.

2. Restrained push-on joint pipe, similar and equal to Fastite Joint Pipe with Fast-Grip gaskets or Flex-Ring joints, by American Ductile Iron Pipe, with restrained push-on joint or restrained

mechanical joint fittings. Fittings shall be standard or compact size conforming to AWWA C110 or C153, respectively.

D. Unless otherwise indicated, gravity sewers, drains, and gravity process piping shall be constructed of ductile iron pipe with Protecto 401 lining or SP2000 by Fast Fabricators and bituminous exterior coating, conforming to AWWA C104, C111, C150 and C151.

E. Gravity process piping shall be constructed with one of the following methods:

1. Unrestrained push-on joint pipe, similar and equal to Fastite Joint Pipe, by American Ductile Iron Pipe, with restrained push-on joint or restrained mechanical joint fittings plus two (2) restrained pipe lengths (i.e., 40 linear-feet) in all directions from the fitting, unless specifically noted otherwise on the drawings. Fittings shall be standard size only, conforming to AWWA C110.

F. All buried ductile iron pipe shall be installed with polyethylene wrap conforming to AWWA C105.

2.02 MATERIALS

A. Ductile iron pipe shall conform to AWWA C151. Pipe shall be supplied in standard lengths as much as possible.

B. Thickness design shall be per AWWA C150, except provide minimum Class based on the following pipe diameters:

1. 14-in and smaller – Class 350
2. 16 to 24-in – Class 300
3. 30 to 60-in – Class 250
4. 64-in – Class 300

C. The pipe supplier shall perform thickness analysis as referenced in Paragraph 2.03. All ductile iron pipe supplied shall meet the minimum wall thickness and pressure class indicated on the drawings.

D. Ductile iron pipe for gravity sewer shall conform to ASTM A746 standards.

2.03 DUCTILE IRON PIPE DESIGN

A. Ductile iron pipe shall have a minimum tensile strength of 60,000 psi with minimum yield strength of 42,000 psi (per AWWA M-41). Design shall be done for external and internal pressures separately using the larger of the two for the net design thickness. Additional allowances shall be made for service allowance and casting tolerance per AWWA C150. The pipe classes determined for various sizes and conditions shall provide the total calculated thickness at a minimum or conform to minimum pipe class specified in Paragraph 2.02.B above, or as shown on the Drawings, whichever is greater.

B. Design for the net thickness for external loading shall be taken as the greater of the following conditions:

1. 2-1/2-ft of cover with AASHTO H-20 wheel loads, with an impact factor of 1.5.

2. Depth from existing ground level of future proposed grade (whichever is greater) to top of pipe as shown on the Drawings, with truck load.

3. Soil Density: 75 lbs/cu ft

4. Laying Conditions; AWWA C150, Type 5.

C. Design for the net thickness shall be based upon the following internal pressure conditions:

1. Design pressure: 150 psi

2. Surge allowance: 100 psi

3. Safety factor: 2

4. Total internal pressure design: 2 (150 + 100) = 500 psi

5. E': 300 psi

D. Copies of design calculations showing that the pipe meets all of the requirements specified herein shall be furnished to the Engineer for approval during shop drawing review in accordance with Section 01300. A yield strength of 42,000 psi shall be used during design calculations.

2.04 END TREATMENTS/JOINTS

A. Ductile iron pipe/fitting joints shall be push-on rubber gasket type or rubber-gasket mechanical joint per AWWA C111 in unrestrained areas. In restrained areas, both pipe and fitting joints shall be push on rubber gasket, locking ring type restrained joints per the manufacturer' standard described in Paragraph C. All gasket materials shall comply with Table 5-1 of AWWA M-41. Rubber-gasket joints shall conform to AWWA C111. Gasket shall be of styrene butadiene rubber (SBR) or of materials compatible with the liquids to be transported and the temperature requirements.

B. Unless otherwise noted, all ductile iron pipe/fitting joints shall be push-on rubber gasket type per AWWA C111 in unrestrained areas.

C. All fittings on water distribution, non-potable water distribution, and force main (pressurized) piping shall be restrained.

D. Restraint for push on joint pipe shall be positive locking "Locked-type" joints manufactured by the pipe and fitting manufacturer that utilize restraint independent of the joint gasket. All restrained joints shall be suitable for the specified test pressure. Joints shall be fabricated of heavy section ductile iron casting. Bolts and nuts shall be low carbon steel conforming to ASTM A193, Grade B7. Restraint for mechanical joint pipe shall use retainer glands for

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restraining joint. Restrained push on joints shall be by one of the following or an approved equal:

- "TR Flex" by US Pipe and Foundary Company
- "Lok-Ring, "Flex Ring (positive locking style)" by the American Cast Iron Pipe Company
- "Snap Lok" by Griffin Pipe Products Company.
- "Superlok" by Clow Water Systems Company

1. The minimum number of restrained joints required for resisting forces at fittings and changes in direction of the pipe shall be determined from the length of restrained pipe on each side of the fittings and changes in direction necessary to develop adequate resisting friction with the soil, The required lengths of restrained joints shall be as shown on the Drawings. If the required length is not specified on the Drawings, the minimum restrained length shall be 10 feet in both directions. Minimally, restrained joints shall be installed at the first two joints away from a fitting.

2. Restrained pipe joints that achieve restraint by incorporating cut out sections in the wall of the pipe shall have a minimum wall thickness at the point of the cut out that corresponds with the minimum specified wall thickness for the rest of the pipe.

3. For up through 48-inch diameter ductile iron pipe only, the following may be used as an alternative restraint system

   a. The optional mechanical joint restraint shall be incorporated in the design of a follower grand, The gland shall be manufactured of ductile iron conforming to ASTM A536. Dimensions of the gland shall be such that it can be used with the standard mechanical joint bell and tee-headed bolts, as specified with the pipe.

   b. The restraint mechanism shall consist of numerous individually activated gripping surfaces to maximize restraint capability. The gripping surfaces shall be wedges designed to spread the bearing surfaces on the pipe. Actuation of the gripping wedges shall be by torque limiting twist-off nuts sized same as T bolts for mechanical joints. When the nut is sheared off, standard hex nut shall remain.

   c. The restraint device for ductile iron pipe shall have a working pressure of at least 250 psi and a safety factor of 2:1.

   d. Pipe manufacturer proprietary mechanical joint restraint systems that utilize a wedge style gripping systems or a gland/ring positive restraint system will be considered acceptable on a case by case basis as determined by the Engineer.

   e. The restraint device shall be EBAA Iron Megalug Series 1100 or 1700 with no equal.

E. Threaded ductile iron flanges for ductile iron pipe shall be fabricated per AWWA C115 and sealed during installation with a special high pressure, full face gasket per AWWA C111. At the pipe manufacturer's option, the use of 250 lb pattern flanges, which are faced and drilled in accordance with ANSI B16.1 may be substituted in order to match valves or other equipment and/or to meet the required working pressure requirements. All flanges shall be rated for the

same pressure as the adjacent pipe in all cases. Compatibility of the flanges with the 250 lb class and higher special class AWWA valves will the responsibility of the Contractor.

1. Flanges shall be pre drilled and then faced after being screwed onto the pipe, with flanges true to 90 degrees of the pipe axis and shall be flush with the end of the pipe.

2. Gaskets shall be full face rubber, 1/8" thick SBR material. Such as American Torseal Gasket, or approved equal.

3. Flanged joints shall be supplied with bolts and nuts on one end, bolt studs with a nut at each end, or studs with nuts on one end where the flange is tapped. The number and size of bolts shall comply with the same standard as the flange. Bolts and nuts shall, except as otherwise specified or noted in the Specifications or on the Drawings, comply with ASTM A193, grade B7.

4. Blind flanges shall mate with regular flanges.

5. Filler flanges and beveled flange fillers shall be furnished faced and drilled complete with extra length bolts.

F. Couplings and Adapters

1. Sleeve type couplings shall be Dresser Style 38, 138 or equal.

   a. Buried sleeve-type couplings shall have a protective wrapping of "Denso" material by DENSO Inc. of Texas or equal. Where "Denso" material is used, the joint shall be packed up with "Densyl mastic" to give an even contour for wrapping with "Densopol" tape. A 1.5 mm thick coating of "Denso" paste shall be applied following by 100 mm or more wide "Densopol" tape wound spirally round the joint with at least 50 percent overlap.

2. Split sleeve type flexible couplings shall be Victaulic Depend-O-Lok Style E x E (unrestrained) or F x F (self-restrained) or equal.

3. Grooved flexible joints for ductile iron pipe sizes 36-in and smaller must be in accordance with AWWA C606 and shall be Victaulic Style 31 or equal.

4. Shouldered flexible joints for ductile iron pipe larger than 36-in shall be Victaulic Style 44 or equal.

## 2.05 FITTINGS

A. Pipe fittings shall be ductile iron with pressure rating of 350 psi for 24-in and smaller piping and 250 psi for 30-in and larger piping. Fittings shall meet the requirements of AWWA C110 or AWWA C153 as applicable. Fittings shall have the same pressure rating, as a minimum, of the connecting pipe.

B. Closures shall be made with mechanical joint ductile iron solid sleeves unless alternate approved coupling systems as described in paragraph 2.03E are used and shall be located in

straight runs of pipe at minimum cover outside the limits of restrained joint sections. Location of closures shall be subject to approval of the Engineer.

C. Weld-on Outlets

1. As an alternative to ductile iron cast fittings, weld-on outlets may be used in certain situations as approved by the Engineer. Welded-on outlets shall be limited to branch outlets having a nominal diameter not greater than 30 percent of the nominal diameter of the main pipe, or 14-inches diameter, whichever is smaller. Welded-on outlets may be provided as radial tee outlet, tangential outlet, or lateral outlet fabricated at a specific angle to the main pipe (in 1 degree increments between 45 and 90 degrees from the axis of the main pipe). Welded-on outlets shall be welded onto the pipe under the supervision of a qualified welder at the same facility where the pipe is manufactured.. The ductile iron pipe manufacturer shall have a minimum of 5 years experience in the fabrication and testing of outlets of similar size and configuration. In no case shall field welding on of outlets be allowed.

2. The joints on welded-on outlets shall be compatible with the connecting pipe and meet where applicable, the requirements of ANSI/AWWA C111/A21.11 and/or ANSI/AWWA C115/A21.15.

3. Welding procedures for welded-on outlets shall be as determined by the pipe manufacturer.

   a. Parent pipe and branch outlet candidate pipe shall be centrifugally cast ductile iron pipe designed in accordance with ANSI/AWWA C150/A21.50 and manufactured in accordance with ANSI/AWWA C151/A21.51. Minimum class shall be: for sizes 4-inch through 54-inch, special thickness class 53.

   b. All welded-on outlets shall be rated for the working pressure indicated on the Drawings and the connecting pipe. Prior to the application of any coating or lining in the outlet area, all weldments for branch outlets to be supplied for this project shall be subjected to an air pressure test of at least 15 psi. Air leakage is not acceptable. A hydrostatic test of 500 psi should also be allowed as an alternative. No leakage is allowed on the hydrostatic test. The hydrostatic test shall be done prior to cutting out the parent pipe.The rating, safety factor and testing must be certified and contained in the manufacturer's submittal package.

2.06 INTERIOR LINING

A. Ductile iron pipe and fittings shall have the same type of lining as specified herein.

B. Potable and Non-Potable water lines and fittings shall have a cement mortar lining in accordance with AWWA C104

C. At the option of the supplier, fittings may be lined in accordance with AWWA C550. Lining shall be NSF 61 certified.

D. All gravity and pressurized piping installed to convey return activated sludge (RAS), waste activated sludge (WAS), scum (SSC), and mixed liquor (ML), all gravity sewers (including

drains), and all fittings connected to these pipelines shall be lined with a ceramic-filled amine-cured epoxy, Protecto 401 by Induron, SP2000 by Fast Fabricators, or approved equal. The lining thickness shall be 40 mils minimum. Application shall be performed by an applicator approved by the coating manufacturer, in accordance with manufacturer's instructions and under controlled conditions at the applicator's shop or the pipe manufacturer's plant. Applicator shall submit a certified affidavit of compliance with manufacturer's instructions and requirements specified herein.

2.07 EXTERIOR COATING

A. Buried ductile iron pipe and fittings shall be installed with a asphaltic coating in accordance with AWWA C151 and C110 respectively.

B. Buried pipe shall be installed with polyethylene encasement. Polyethylene encasement shall have a minimum thickness of 8 mils and meet or exceed the minimum standards established by AWWA C105, current edition. Acceptable manufacturers include Fulton or approved equal.

1. Polyethylene encasement shall meet minimum size requirements per TABLE 3 of section 2.15 of DIPRA's Installation Guide For Ductile Iron Pipe.

2. Test results from an independent testing agency certifying that the polyethylene encasement meets all criteria established by AWWA C105, current edition, shall be submitted to the Engineer prior to approval of the polyethylene encasement for use. In general, samples shall be submitted and include test results in accordance with the AWWA standard associated with tensile strength, elongation, dielectric strength, impact resistance, and propagation tear resistance.

3. A 2-inch wide plastic adhesive tape, such as Calpico Vinyl, Polykén 900, or approved equal, shall be used for sealing seams, cuts, or tears in polyethylene encasement. Duct tape shall not be allowed.

PART 3 EXECUTION

3.01 GENERAL

A. Care shall be taken in loading, transporting and unloading to prevent injury to the pipe, lining or coatings. Pipe and fittings shall not be dropped or skidded against each other. Slings, hooks or pipe tongs shall be used fir pipe handling. All pipe and fittings shall be examined before laying and no piece shall be installed which is found to be defective. Any damage to the pipe, lining or coatings shall be repaired per manufacturer's recommendations. Handling and laying of pipe and fittings shall be in accordance with manufacturer's instruction and as specified herein.

B. If any defective pipe is discovered after it has been laid, it shall be removed and replaced with a sound pipe in a satisfactory manner. All pipe and fittings shall be thoroughly cleaned before laying, shall be kept clean until they are used in the work and when installed or laid, shall conform to the lines and grades required.

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C. Materials, if stored, shall be kept safe from damage. The interior of all pipe, fittings, and other appurtenances shall be kept free from dirt, excessive corrosion or foreign matter at all times.

D. Pipe shall not be stacked higher than the limits recommended by its manufacturer. The bottom tier shall be kept off the ground on timbers, rails, or concrete. Stacking shall conform to manufacturer's recommendations and/or AWWA C600.

E. Gaskets for mechanical and push-on joints to be stored shall be placed in a cool location out of direct sunlight. Gaskets shall not come in contact with petroleum products. Gaskets shall be used on a first-in, first-out basis.

## 3.02 INSTALLING DUCTILE IRON PIPE AND FITTINGS

A. Ductile iron pipe and fittings shall be installed in accordance with requirements AWWA C600, except as otherwise specified herein. A firm, even bearing throughout the length of the pipe shall be provided by digging bell holes at each joint and by tamping backfill materials at the side of the pipe to the springline per details shown on the Drawings. Blocking will not be permitted. If any defective pipe or fitting is discovered after it has been laid, it shall be removed and replaced with a sound pipe or fitting in a satisfactory manner by the Contractor, at his/her own expense.

B. All pipe and fittings shall be kept clean until they are used in the work and shall be sound and thoroughly cleaned before laying. When laid, the pipe and fittings shall perform to the lines and grades required. When laying is not in progress, including lunch breaks, open ends of the pipe shall be closed by a watertight plug or other approved means. Sufficient backfill shall be placed to prevent flotation. The deflection at joints shall not exceed that recommended by the manufacturer.

C. All ductile iron pipe laid underground shall have a minimum of 2.5 feet of cover unless otherwise shown on the Drawings or as specified herein. Pipe shall be laid such that the invert elevations shown on the Drawings are not exceeded.

D. Fittings, in addition to those shown on the Drawings shall be provided, where required, in crossing utilities which may be encountered upon opening the trench. Solid sleeve closures shall be installed at locations approved by the Engineer.

E. The pipe interior shall be maintained dry and broom clean throughout the construction period.

F. When field cutting the pipe is required, the cutting shall be done by machine, leaving a smooth cut at right angles to the axis of the pipe. The end of the cut pipe shall be beveled to conform to the manufacture's recommendations for the spigot end. Any coating removed from the cut end shall be repaired according to manufacturer's recommendation and/or Section 2 (whichever method is more stringent in the opinion of the Engineer). Cement lining shall be undamaged. Cutting of restrained joint pipe will not be allowed, unless approved at specific joints in conjunction with the use of restrainer glands by EBAA Iron or field adaptable restrained joints. Where field cuts are permitted, the pipe to be cut shall be supplied by the factory as "gauged full length". Should full length gauged pipe be unavailable, the pipe to be cut shall be field gauged at the location of the new spigot using a measuring tape, or other means approved by the manufacturer, to verify that the diameter is within the tolerances permitted in Table 1 of AWWA C151.

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G. Jointing Ductile-Iron Pipe

1. Push-on joints shall be made in strict accordance with manufacturer's instructions, AWWA C600 and Appendix B of AWWA C111. If there is conflict, the manufacturer's instructions shall take precedence. Pipe shall be laid with bell ends looking ahead. A rubber gasket shall be inserted in the groove of the bell end of the pipe. The joint surfaces shall be cleaned and lubricated and the plain end of the pipe shall be aligned with the bell of the pipe to which it is to be joined and pushed home. After joining the pipe, a metal feeler shall be used to make certain that the rubber gasket is properly seated.

2. Mechanical joints shall be assembled in strict accordance with the manufacturer's instructions, AWWA C600 and Appendix A of AWWA C111. If there is conflict, the manufacturer's instructions shall take precedence. Pipe shall be laid with bell ends looking ahead. To assemble the joints in the field, thoroughly clean and lubricate the joint surfaces and rubber gasket. Bolts shall be tightened to the specified torques. Under no condition shall extension wrenches or pipe over handle of ordinary ratchet wrench be used to secure greater leverage. After installation, apply a bitumastic coating to bolts and nuts and install polyethylene encasement as specified.

3. Bolts in mechanical or restrained joints shall be tightened alternately and evenly. Restraint for mechanical joint pipe shall use retainer glands for restraining joint. All restrained mechanical joints shall be suitable for the specified test pressure.

4. Restrained joints shall be installed according to pipe manufacturer's instructions.

5. Flanged joints shall be assembled in strict accordance with the manufacturer's instructions and Appendix C of AWWA C111. If there is conflict, the manufacturer's instructions shall take precedence. Extreme care shall be taken to ensure that there is no restraint on opposite ends of pipe or fitting, which would prevent uniform gasket compression, cause unnecessary stress, bending or torsional strains, or distortion of flanges or flanged fittings. Adjoining push on joints shall not be assembled until flanged joints have been tightened. Flange bolts shall be tightened uniformly to compress the gasket uniformly and obtain a seal. Flange bolts shall be left with approximately 1/2-inch projection beyond the face of the nut after tightening. After installation apply a bitumastic coating to the bolts and nuts as specified.

6. Sleeve couplings shall only be installed for closure or as shown on the Drawings. Couplings shall not be assembled until adjoining joints have been assembled. After installation. Apply a heavy bitumastic coating to the bolts and nuts and install protective wrap recommended by the manufacturer or as required herein. Care shall be exercised to insure that the insulating properties of insulating and dielectric couplings are maintained.

H. All blowoffs, outlets, valves, fittings and other appurtenances required shall be set and jointed as indicated on the Drawings in accordance with manufacturer's instructions.

I. Install polyethylene encasement around all buried ductile iron pipe.

1. Polyethylene encasement shall be installed per ANSI/ AWWA C105/A21.5, Method 'A' in accordance with section 2.15 of DIPRA's Installation Guide For Ductile Iron Pipe.

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2. A fabric type or padded sling shall be used when handling polyethylene encased pipe to prevent damage to the polyethylene encasement.

3. All seams in the polyethylene encasement shall be sealed completely with approved 2-inch wide plastic adhesive tape.

4. Extreme care shall be taken to ensure that all rips or tears in the polyethylene encasement are properly repaired with additional tape and film as described in ANSI/AWWA C105/A21.5

5. Extreme care shall be taken when backfilling to avoid damaging the polyethylene encasement

3.03 CONNECTIONS TO STRUCTURES

A. Wherever a pipe 3-in in diameter or larger passes from concrete to earth horizontally, two flexible joints spaced from 2 to 4-ft apart depending on pipe size shall be installed, within 2-ft of the exterior face of the wall, whether or not shown on the Drawings.

B. Unless otherwise specified, all pipes passing through a wall will utilize a wall sleeve designed to pass the thrust through the wall via restrained piping.

C. Piping underneath structures shall be concrete encased.

3.04 FILLING AND TESTING

A. After installation, the pipe shall be tested for compliance as specified herein. Furnish all necessary equipment and labor for the hydrostatic pressure test on the pipelines.

B. Submit detailed test procedures and method for Engineer's review. In general, testing shall be conducted in accordance with AWWA C600. The method and procedures for performing the hydrostatic pressure test shall be approved by the Engineer. Submit the plan for testing to the Engineer at least 10 days before starting a test.

C. Pressure pipelines shall be subjected to a hydrostatic pressure 1.25 times the working pressure at the highest point along the test segment. This test pressure shall be maintained for a minimum of 2 hours. The hydrostatic testing allowances shall not exceed those indicated in AWWA C600. Provide suitable restrained bulkheads as required to complete the hydrostatic testing specified.

D. Contractor shall make any taps and furnish all necessary caps, plugs etc, as may be required in conjunction with performing the testing.

E. Gravity pipelines shall be subjected to hydrostatic pressure test as specified in AWWA C600.

F. All valves and valve boxes shall be properly located and installed and operable prior to testing. Bulkheads shall be provided with a sufficient number of outlets for filling and draining the line and for venting air.

G. Hydrostatic pressure tests shall conform to Section 5.2 of AWWA C600. Furnish gauges, meters, pressure pumps and other equipment needed to fill the line slowly and perform the required hydrostatic pressure tests.

H. The Owner will provide a source of supply from the existing non-potable water distribution system for Contractor's use in filling the lines. The line shall be slowly filled with water and the specified test pressure shall be maintained in the pipe for the entire test period by means of a pump furnished by the Contractor. Provide accurate means for measuring the quantity of makeup water required to maintain this pressure.

I. Duration of pressure test shall not be less than 2 hours. All leaks evident at the surface shall be repaired and leakage eliminated regardless of the total leakage as shown by test. Lines which fail to meet tests shall be repaired and retested as necessary until test requirements are complied with. Defective materials, pipes, valves and accessories shall be removed and replaced.

3.05 CLEANING

A. At the conclusion of the work, thoroughly clean the entire pipe by flushing with water or other means to remove all dirt, stones, pieces of wood, or other material which may have entered during the construction period. All debris shall be removed from the pipeline. The lowest segment outlet shall be flushed last to assure debris removal.

B. After the pipe has been cleaned and if the groundwater level is above the pipe or water in the pipe trench is above the pipe following a heavy rain, the Engineer will examine the pipe for leaks. If defective pipes, fittings or joints are discovered at this time, they shall be repaired or replaced by the Contractor.

END OF SECTION

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SECTION 02622

POLYVINYL CHLORIDE (PVC) YARD PIPE

PART 1 GENERAL

1.01 SCOPE OF WORK

A. Furnish all labor, materials, equipment and incidentals required and install and test polyvinyl chloride (PVC) yard pipe and fittings, complete as shown on the Drawings and as specified herein.

B. Pipe or piping refers to all pipe, fittings, material and appurtenances required to construct PVC yard pipe complete, in place.

1.02 RELATED WORK

A. Testing, cleaning of sewer pipe is included in Section 01445.

B. Trenching, backfilling and compacting is included in 02221

C. Fill materials, including granular bedding materials, are included in Section 02221.

D. Pavement repair and resurfacing are included in Section 02501.

E. Ductile iron fittings are included in Section 02616.

F. Valves, hydrants, couplings and appurtenances are included in Section 02640.

G. Loaming and hydroseeding is included in Section 02930.

1.03 SUBMITTALS

A. Submit, in accordance with Section 01300, the name of the pipe and fitting manufacturers and a list of materials to be furnished by each manufacturer

B. Shop Drawings including piping layouts and schedules shall include dimensioning, fittings, types and locations of valves and appurtenances, joint details, methods and location of supports, anchorage, gasket material, grade of material and all other pertinent technical information for all items to be furnished.

C. Prior to each shipment of pipe, certified test reports that the pipe for this Contract was manufactured and tested in accordance with the ASTM and AWWA Standards specified herein shall be submitted.

1.04 REFERENCE STANDARDS

A. American Society for Testing and Materials (ASTM)

1. ASTM D1784 - Standard Specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds.

2. ASTM D2241 - Standard Specification for Poly (Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series).

3. ASTM D2321 - Standard Practice for Underground Installation of Thermoplastic Pipe for Sewer and Other Gravity-Flow Applications

4. ASTM D3139 - Standard Specification for Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals.

5. ASTM F477 - Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.

B. American Water Works Association (AWWA)

1. AWWA C110 - Ductile-Iron and Gray-Iron Fittings, 3-in Through 48-in (75mm Through 1219mm) for Water.

2. AWWA C111 - Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.

3. AWWA C600 - Installation of Ductile-Iron Water Mains and Their Appurtenances.

4. AWWA C-605 – Underground Installation of Polyvinyl Chloride (PVC) Pressure Pipe and Fittings for Water.

5. AWWA C651 - Disinfecting Water Mains.

6. AWWA C900 - Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 4-in through 12-in for Water Distribution.

7. AWWA C905 - Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings 14-in through 48-in for Water Transmission and Distribution.

8. AWWA M-23 – Manual of Water Supply Practices PVC Pipe, Design and Installation.

C. National Sanitation Foundation (NSF)

1. Standard No. 14 - Plastic Piping Components and Related Materials.

2. Standard No. 61 - Drinking Water System Components - Health Effects.

D. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.05 QUALITY ASSURANCE

A. Inspections of the pipe may also be made by the Engineer or other representatives of the Owner after delivery. The pipe shall be subject to rejection at any time on account of failure to meet any of the requirements specified herein, even though sample pipes may have been accepted as satisfactory at the place of manufacture. Pipe rejected after delivery shall be marked for identification and shall be removed from the job at once.

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1.06 SYSTEM DESCRIPTION

A. The equipment and materials specified herein are intended to be of standard types for use in transporting potable water, non-potable water, chlorine solution, and sewage.

B. Note information in pipe schedule on Drawings, if any and in this Section, especially concerning pressures, minimum thickness, etc. In case of a conflict, information given in the pipe schedule shall govern.

C. Contractor is responsible for compatibility between pipe materials, fittings and appurtenances.

D. Unless otherwise noted, PVC pipe systems shall be designed for the following condition(s).

1. Schedule 80

2. Pressure:

a. Operating: 80 PSI

b. Testing: 125 PSI

1.07 DELIVERY, STORAGE AND HANDLING

A. All items shall be bundled or packaged in such a manner as to provide adequate protection of the ends during transportation to the site. Any pipe damaged in shipment shall be replaced as directed by the Engineer.

B. PVC items deteriorate in sunlight and are slightly brittle, especially at lower temperatures, so care shall be taken in loading, transporting and unloading items to prevent injury to the items. All items shall be examined before installation and no piece shall be installed which is found to be defective. Handling and installation of pipe and fittings shall be in accordance with the manufacturer's instructions, referenced standards and as specified herein.

C. Any pipe or fitting showing a crack or which has received a blow that may have caused an incident fracture, even though no such fracture can be seen, shall be marked as rejected and removed at once from the work.

D. Any gouges or scratches that extend 10 percent or more into the pipe wall shall be cause for rejection of that pipe. The undamaged portion may cut off and used. Rejected materials shall be clearly marked as rejected, segregated and removed from the site.

E. While stored, pipe shall be adequately supported from below at not more than 3-ft intervals to prevent deformation. The pipe shall be stored in stacks no higher than 5 rows.

F. Pipe and fittings shall be stored in a manner which will keep them at ambient outdoor temperatures and out of the sunlight or delivered to the site so that no pipe is exposed to sunlight for more than 60 days. Temporary shading as required to meet this requirement shall be provided. Simple covering of the pipe and fittings which allows temperature buildup or direct or indirect sunlight will not be permitted.

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G. If any defective item is discovered after it has been installed, it shall be removed and replaced with an exact replacement item in a satisfactory manner by the Contractor, at the Contractor's own expense. All pipe and fittings shall be thoroughly cleaned before installation and the interior shall be kept clean until testing

H. In handling the items, use special devices and methods as required to achieve the results specified herein. No uncushioned devices shall be used in handling the item.

## PART 2 PRODUCTS

### 2.01 POLYVINYL CHLORIDE (PVC) PIPE AND FITTINGS

A. PVC pressure pipe sized 4 through 12-in shall conform to the requirements of ASTM D1785 or AWWA C900. All piping shall be Schedule 80 or Class 200 with a Dimension Ratio of 14. The pipe shall be PVC 1120 made from PVC compounds Class 12454-A or 12454-B as defined in ASTM D1784. Each pipe length shall be marked with the manufacturer's name or trademark, size, material code, and pressure class.

B. PVC fittings shall meet the requirements of ASTM D178 or AWWA C900 and be of the same (or higher) pressure rating as the pipeline.

C. Where restrained joints are required, restraining glands shall be installed. Restraining glands for PVC pipe shall conform to AWWA C111 and be by EBAA Iron Sales Inc.

## PART 3 EXECUTION

### 3.01 INSTALLATION OF PVC PIPE AND FITTINGS

A. No single piece of pipe shall be laid unless it is straight. The centerline of the pipe shall not deviate from a straight line drawn between the centers of the openings at the ends of the pipe by more than 1/16-in per foot of length. If a piece of pipe fails to meet this requirement, check for straightness, it shall be rejected and removed from the site. Laying instructions of the manufacturer shall be explicitly followed.

B. If any defective pipe is discovered after it has been installed, it shall be removed and replaced with a sound pipe in a satisfactory manner at no additional cost to the Owner. All pipe and fittings shall be thoroughly cleaned before installation, shall be kept clean until they are used in the work and when laid, shall conform to the lines and grades required.

C. As soon as the excavation is complete to normal grade of the bottom of the trench, bedding shall be placed, compacted and graded to provide firm, uniform and continuous support for the pipe. Bell holes shall be excavated so that only the barrel of the pipe bears upon the bedding. The pipe shall be laid accurately to the lines and grades indicated on the Drawings. Blocking under the pipe will not be permitted. Bedding shall be placed evenly on each side of the pipe to mid-diameter and hand tools shall be used to force the bedding under the haunches of the pipe and into the bell holes to give firm continuous support for the pipe. Bedding shall then be placed to 12-in above the top of the pipe. The initial 3-ft of backfill above the bedding shall be placed in 1-ft layers and carefully compacted. Generally the compaction shall be done evenly on each side of the pipe and compaction equipment shall not be operated directly over the pipe until sufficient backfill has been placed to ensure that such compaction equipment

will not have a damaging effect on the pipe. Equipment used in compacting the initial 3-ft of backfill shall be approved by the pipe manufacturer's representative prior to use.

D. All piping shall be sound and clean before installation. When installation is not in progress, including lunchtime, the open ends of the pipe shall be closed by watertight plug or other approved means. Good alignment shall be preserved during installation. The deflection at joints shall not exceed that recommended by manufacturer. Fittings, in addition to those shown on the Drawings, shall be provided, if required, in crossing utilities that may be encountered upon opening the trench.

E. When cutting pipe is required, the cutting shall be done by machine, leaving a smooth cut at right angles to the axis of the pipe. Cut ends of pipe to be used with a bell shall be beveled to conform to the manufactured spigot end and a reference mark made at the same distance from the pipe end as measured from a factory marked end from the same manufacturer.

F. The Engineer may examine each bell and spigot end to determine whether any preformed joint has been damaged prior to installation. Any pipe having defective joint surfaces shall be rejected, marked as such and immediately removed from the job site.

G. Each length of the pipe shall have the assembly mark aligned with the pipe previously laid and held securely until enough backfill has been placed to hold the pipe in place. Joints shall not be "pulled" or "cramped".

H. Before any joint is made, the pipe shall be checked to assure that a close joint with the next adjoining pipe has been maintained and that the inverts are matched and conform to the required grade. The pipe shall not be driven down to grade by striking it.

I. Precautions shall be taken to prevent flotation of the pipe in the trench.

J. When moveable trench bracing such as trench boxes, moveable sheeting, shoring or plates are used to support the sides of the trench, care shall be taken in placing and moving the boxes or supporting bracing to prevent movement of the pipe, or disturbance of the pipe bedding and the backfill. Trench boxes, moveable sheeting, shoring or plates shall not be allowed to extend below top of the pipe. As trench boxes, moveable sheeting, shoring or plates are moved, pipe bedding shall be placed to fill any voids created and the backfill shall be recompacted to provide uniform side support for the pipe.

K. Concrete thrust blocks shall be installed at all fittings and other locations as required. Concrete shall be placed against undisturbed material and shall not cover joints, bolts or nuts, or interfere with the removal of any joint. Wooden side forms shall be provided for thrust blocks.

L. Restrained joints shall be installed in accordance with the manufacturer's instructions. At a minimum, restrained joints shall be installed for the first two joints away from a fitting.

3.02 JOINTING PVC PIPE (Push-on type)

A. Joints shall be made in strict accordance with the manufacturer's instructions. Pipe shall be laid with bell ends looking ahead. A rubber gasket shall be inserted in the groove of the bell end of the pipe and the joint surfaces cleaned and an approved lubricant applied in accordance

with the manufacturer's recommendations. The plain end of the pipe to be installed shall then be inserted into the bell of the pipe to which it is to be joined and when in alignment pushed home with a come-along or by other means. Check that the reference mark on the spigot end is flush with the end of the bell.

3.03 JOINTING MECHANICAL JOINT FITTINGS

A. Mechanical joints at valves, fittings and where designated shall be in accordance with the AWWA C111 or ASTM Standards and the instructions of the manufacturer. Suitable PVC to cast iron adaptors shall be installed prior to installing fittings. PVC beveled spigot shall be cut flush prior to insertion in mechanical joint pipe. To assemble the joints in the field, thoroughly clean the joint surfaces and rubber gasket with soapy water before tightening the bolts. Bolts shall be tight to the specified torques. Under no condition shall extension wrenches or pipe over handle of ordinary ratchet wrench be used to secure greater leverage.

3.04 SOLVENT WELDED JOINTS

A. Fittings shall be the socket type for solvent welded joints conforming to ASTM D2467 where Schedule 80 pipe is shown on the Drawings. Fittings shall be manufactured from PVC compound meeting ASTM D1784, Class 12454-B. Solvent cement shall be as specified in ASTM D2564.

B. Pipe, fittings, and solvent for use with potable water shall be certified by NSF in accordance with NSF Standard No. 14 and the seal shall be included on the pipe. The cement shall be manufactured by Oatey Industrial Grade Low VOC Heavy Duty Gray, by Oatey Corp., Cleveland OH.

C. For chlorine solution piping, schedule 80 PVC pipe, the cement shall be Oatey Industrial Grade Low VOC Heavy Duty Gray, by Oatey Corp., Cleveland OH or engineer approved equal.

3.05 FILLING AND TESTING

A. After installation, the pipe shall be tested for compliance as specified herein. Furnish all necessary equipment and labor for the hydrostatic pressure test on the pipelines.

B. Submit detailed test procedures and method for Engineer's review. In general, testing shall be conducted in accordance with AWWA C605. The method and procedures for performing the hydrostatic pressure test shall be approved by the Engineer. Submit the plan for testing to the Engineer at least 10 days before starting a test.

C. Pressure pipelines shall be subjected to a hydrostatic pressure of 125 psi or 1.25 times the working pressure at the highest point along the test segment. This test pressure shall be maintained for a minimum of 2 hours. The hydrostatic testing allowances shall not exceed those indicated in AWWA C605. Provide suitable restrained bulkheads as required to complete the hydrostatic testing specified.

D. Contractor shall make any taps and furnish all necessary caps, plugs etc, as may be required in conjunction with performing the testing.

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E. All valves and valve boxes shall be properly located and installed and operable prior to testing. Bulkheads shall be provided with a sufficient number of outlets for filling and draining the line and for venting air.

F. Hydrostatic pressure tests shall conform to Section 7.3 of AWWA C605. Furnish gauges, meters, pressure pumps and other equipment needed to fill the line slowly and perform the required hydrostatic pressure tests.

G. The Owner will provide a source of supply from the existing non-potable water distribution system for Contractor's use in filling the lines. The line shall be slowly filled with water and the specified test pressure shall be maintained in the pipe for the entire test period by means of a pump furnished by the Contractor. Provide accurate means for measuring the quantity of makeup water required to maintain this pressure.

H. Duration of pressure test shall not be less than 2 hours. All leaks evident at the surface shall be repaired and leakage eliminated regardless of the total leakage as shown by test. Lines which fail to meet tests shall be repaired and retested as necessary until test requirements are complied with. Defective materials, pipes, valves and accessories shall be removed and replaced.

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SECTION 02640

# VALVES, HYDRANTS AND APPURTENANCES

## PART 1 GENERAL

### 1.01 SCOPE OF WORK

A. Furnish all labor, materials, equipment and incidentals required and provide all buried valves, valves in manholes and underground vaults, hydrants and appurtenances complete with actuators and all accessories as shown on the Drawings and as specified herein.

B. Valves specifically excluded from this Section are as follows:

1. All non-buried valves

2. All valves for plumbing work.

3. All valves for heating and ventilation work.

4. All valves specifically included with equipment.

### 1.02 RELATED WORK

A. Excavation, backfill, fill and grading are included in Section 02221.

B. Concrete is included in Division 3.

C. Electric valve actuators are included in Division 15.

D. Electrical work is included in Division 16.

### 1.03 SUBMITTALS

A. Submit, in accordance with Section 01300, materials required to establish compliance with this Section for shop drawings. Submittals shall include the following:

1. Manufacturer's literature, illustrations, specifications and engineering data including:

a. Dimensions.

b. Size.

c. Materials of construction.

d. Weight.

e. Protection coating.

f. Actuator weight.

g. Calculations for actuator torque where applicable.

h. Wiring diagram including:

1) Ladder diagrams.

2) Point-to-point wiring.

B. Test Reports

1. Four copies of all certified shop test results specified herein.

C. Operation and Maintenance Manuals

1. Submit complete operation and maintenance manuals including copies of all approved Shop Drawings.

D. Certificates

1. Certificates of compliance where required by referenced standards: For each valve specified to be manufactured and/or installed in accordance with AWWA and other standards, submit an affidavit of compliance with the appropriate standards, including certified results of required tests and certification of proper installation.

E. Statement of Conformance

1. Provide a Statement of Conformance letter stating conformance to the Drawings and Specifications with all exceptions noted. Statement of conformance must be signed by an individual authorized to make such statements. Omission of the Statement of Conformance letter or failure to note all exceptions to the Drawings and Specifications is justification for submittal rejection.

1.04 REFERENCE STANDARDS

A. Comply with applicable provisions and recommendations of the following, except as otherwise shown or specified.

B. American Water Works Association (AWWA)

1. AWWA C111 - Rubber-Gasket Joints for Ductile-Iron and Pressure Pipe and Fittings.

2. AWWA C509 - Resilient-Seated Gate Valves for Water Supply Service.

3. AWWA C515 - Reduced Wall, Resilient-Seated Gate Valves for Water Supply Service

4. AWWA C517 – Resilient-Seated Cast Iron Eccentric Plug Valves

5. AWWA C800 – Underground Service Lines and Fittings

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C. American National Standards Institute (ANSI)

1. ANSI B16.1 – Cast Iron Pipe Flanges and Flanged Fittings.

D. American Society for Testing and Materials (ASTM)

1. ASTM A48 - Standard Specification for Gray Iron Castings.

2. ASTM A126 - Standard Specification for Gray Iron Castings for Valves, Flanges and Pipe Fittings

3. ASTM A153 - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware

4. ASTM A276 - Standard Specification for Stainless Steel Bars and Shapes.

5. ASTM A536 - Standard Specification for Ductile Iron Castings.

E. The Society for Protective Coatings (SSPC)

1. SSPC SP-6 - Joint Surface Standard Commercial Blast Cleaning

F. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.05 QUALITY ASSURANCE

A. Manufacturer's Qualifications

1. Valves and appurtenances provided under this Section shall be the standard product in regular production by manufacturers whose products have proven reliable in similar service for at least 10 years. If required, the manufacturer shall furnish evidence of installation in satisfactory operation.

2. All units of the same type shall be the product of one manufacturer.

B. Design Criteria

1. All valves and appurtenances shall be new and in perfect working condition. Valves shall be designed for continuous use with a minimum of maintenance and service required and shall perform the required function without exceeding the safe limits for stress, strain or vibration. In no case will used or damaged valves be acceptable. The selection of equipment to meet the specified design conditions is the responsibility of the Contractor. Both workmanship and material shall be of the very best quality and shall be entirely suitable for the service conditions specified.

C. Source Quality Control

1. Resilient-seated gate valves shall be shop tested in accordance with AWWA C509.

2. Obtain each type of valve from no more than one manufacturer.

3. Plug valves shall be hydrostatically tested for 30 minutes at two times the maximum working pressure, with no evidence of distress, leakage or weeping. Plug valves shall be capable of providing drop-tight shut-off up to the full pressure rating.

1.06 DELIVERY, STORAGE AND HANDLING

A. Deliver materials to the site to ensure uninterrupted progress of the work.

B. Protect threads and seats from corrosion and damage. Rising stems and exposed stem valves shall be coated with a protective oil film which shall be maintained until time of use.

C. Furnish covers for all openings.

1. All valves 3-in and larger shall be shipped and stored on site until time of use with wood or plywood covers on each valve end.

2. All valves smaller than 3-in shall be shipped and stored as above except that heavy card board covers may be furnished instead of wood.

D. Store equipment to permit easy access for inspection and identification. Any corrosion in evidence at the time of Owner acceptance shall be removed, or the valve shall be removed from the job.

E. Store all equipment in covered storage off the ground.

1.08 COORDINATION

A. Review installation procedures under other Sections and coordinate with the work which is related to this Section including buried piping installation, site utilities, piping insulation, heating, ventilating and air conditioning, plumbing and chemical feed facilities.

B. Coordinate the location and placement of concrete thrust blocks when required.

PART 2 PRODUCTS

2.01 GENERAL

A. All buried valves shall open counter-clockwise.

B. The use of a manufacturer's name and/or model or catalog number is for the purpose of establishing the standard of quality and general configuration desired.

C. Valves shall be of the size shown on the Drawings or as noted and as far as possible equipment of the same type shall be identical and from one manufacturer.

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D. Valves shall have the name of the maker, nominal size, flow directional arrows, working pressure for which they are designed and standard to which they are manufactured cast in raised letters on some appropriate part of the body.

E. Unless otherwise noted, valves shall have a minimum working pressure of 150 psi or be of the same working pressure as the pipe they connect to, whichever is higher, and suitable for the pressures noted where they are installed.

F. Valves shall be of the same nominal diameter as the pipe or fittings they are connected to. Except as otherwise noted, joints shall be mechanical joints, with joint restraint where the adjacent piping is required to be restrained.

G. Valves shall be especially constructed for buried service.

2.02 VALVE BOXES

A. All gate and plug valves shall be provided with extension shafts, operating nuts and valve boxes as follows:

1. Extension shafts shall be Type 304 stainless steel and the operating nut shall be 2-in square. Shafts shall be designed to provide a factor of safety of not less than four. Operating nuts shall be pinned to the shafts.

2. Top of the operating nut shall be located 2-in below the rim of the valve box.

3. Valve boxes shall be as manufactured by Clow; Mueller; Tyler; or equal and shall be a heavy-pattern cast iron, three-piece, telescoping type box with dome base suitable for installation on the buried valves. Inside diameter shall be at least 4-1/2-in. Barrel length shall be adapted to the depth of cover, with a lap of at least 6-in when in the most extended position. A means of lateral support for the valve extension shafts shall be provided in the top portion of the valve box.

4. The upper section of each box shall have a top flange of sufficient bearing area to prevent settling. The bottom of the lower section shall enclose the stuffing box and operating nut of the valve and shall be oval.

5. An approved operating key or wrench shall be furnished except where floor stands are required.

6. All fasteners shall be Type 304 stainless steel.

2.03 RESILIENT SEATED GATE VALVES

A. Valves 3-in through 30-in shall be manufactured in accordance with AWWA C509 and as specified herein. Valves shall be:

1. The Series 2639 and 2640 resilient seated gate valve (available in 2-in through 12-in) by Clow Valve Company (A Division of McWane Inc.) of Oskaloosa, Iowa;

2. The 8000 Series resilient seated gate valve (available in 3-in through 12-in) by Kennedy Valve Company (A Division of McWane Inc.) of Elmira, New York;

3. The RS series resilient wedge gate valve (available in 3-in through 12-in) by M&H Valve Company of Anniston, Alabama;

4. The Series 2360 resilient wedge gate valve (available in 2-in through 12-in) by Mueller Company of Decatur, Illinois;

5. The Model A-USP0 resilient wedge gate valve (available in 2-in through 12-in) by the US Pipe & Hydrant Division of Mueller Company of Decatur, Illinois;

6. Or equal.

B Alternatively, valves 3-in through 36-in shall be manufactured in accordance with AWWA C515 and as specified herein. Valves shall be:

1. The Series 2638 resilient seated gate valve (available in 4-in through 36-in) by Clow Valve Company (A Division of McWane Inc.) of Oskaloosa, Iowa;

2. The 7000 Series resilient seated gate valve (available in 4-in through 36-in) by Kennedy Valve Company (A Division of McWane Inc.) of Elmira, New York.

3. The RS series resilient wedge gate valve (available in 4-in through 36-in) by M&H Valve Company of Anniston, Alabama;

4. The Series 2500 ductile iron resilient wedge gate valve (available in 2-in through 48-in) by American Flow Control of Birmingham, Alabama;

5. The Series 2361 ductile iron resilient wedge gate valve (available in 14-in through 48-in) by Mueller Company of Decatur, Illinois;

6. The Model A-USP1 resilient wedge gate valve (available in 14-in through 48-in) by the US Pipe & Hydrant Division of Mueller Company of Decatur, Illinois;

7. Or equal.

C. Valves shall be provided with a minimum of two O-ring stem seals.

D. Bonnet and gland bolts and nuts shall be Type 304 or 316 stainless steel. The hot-dip process in accordance with ASTM A153 is not acceptable. Allen-wrench type bonnet and gland fastening shall not be acceptable and will be rejected.

E. Wedges shall be totally encapsulated.

F. Units shall be, in addition, UL and FM approved.

G. Cast the word "OPEN" and an arrow indicating direction to open on each valve body or operator.

H. Operating nut for all gate valves shall be 2-in square.

I. Extension stems shall be fabricated from solid steel. Stems shall not be smaller in diameter than the valve stem. Equip stem with wrench nut. Ensure all stem connections are pinned.

J. Valves shall be non-rising stem.

K. AWWA requirements for thrust collar and stem to be integrally cast (not pinned on), and copper alloy valve stems shall be strictly enforced.

L. Valves shall have mechanical joint ends compliant with AWWA C111 unless otherwise noted.

M. A 10-year warranty shall be provided for all resilient seated gate valves furnished on the Project.

## 2.04 TAPPING SLEEVES AND TAPPING VALVES

A. Tapping sleeves shall be of ductile iron, designated for working pressure not less than 200 psi. Armored end gaskets shall be provided for the full area of the sleeve flanges. Sleeves shall be as manufactured by A.P. Smith Division of U.S. Pipe; Mueller; Clow or equal. Nuts and bolts shall be Type 304 stainless steel.

B. Tapping valves shall conform to the requirements specified above for gate valves except that one end shall be flanged and one mechanical. Tapping valves shall be provided with an oversized opening to permit the use of full size cutters.

## 2.05 PLUG VALVES

A. Plug valves specified herein shall be suitable for buried service, and shall be Series PEC by DeZurik Water Controls of Sartell, Minnesota; the Cam-Centric® by Val-Matic Valve and Manufacturing Corporation of Elmhurst, Illinois. Plug valves shall conform to the minimum requirements of AWWA C517, in addition to the requirements specified herein.

B. All plug valves shall be of the non-lubricated, eccentric type with bodies and plugs of semi-steel construction. Valves shall be rated for a minimum working pressure of 175 psig for 3-in through 12-in and 150 psig for 14-in through 72-in valves. The area at the valve port shall be at least 80 percent of the full pipe area. All valves shall open by turning the wrench nut counter-clockwise.

C. All plug valves for what ever service, shall be capable of passing "pigging" cleaning equipment (using a Girard or similar cleaning pig of full nominal pipeline diameter) in either direction and manufacturer shall so certify that this may be done without the use of special equipment.

D. Valves shall have balanced plugs with a resilient facing of Nitrile (Buna-N) solidly bonded thereto to assure bubble-tight shutoff low torque requirements.

E. Seats shall have a welded-in overlay of 90 percent pure nickel on all surfaces contacting the plug face.

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F. Valves shall be furnished with bolted bonnets and self-adjusting chevron-type packing. Packing shall be replaceable without disassembling the valve or removing the bonnet from the valve.

G. Corrosion-resistant, permanently-lubricated bearings shall be provided at both ends of the valve shafts.

H. All valves shall be supplied with mechanical joint ends conforming to AWWA C111, unless otherwise noted herein.

I. All exterior hardware on valves shall be of Type 316 stainless steel.

2.06 BALL VALVES FOR PVC PIPE

A. Ball valves for PVC pipe shall be of PVC Type 1 with union, socket, threaded, or flanged ends as required. Ball valves shall be full port, full flow, all plastic construction, 150 PSI rated with Teflon seat seals and T-handles. PVC ball valves shall be as manufactured by Georg Fischer, Celanese Piping Systems, Plastiline, or equal.

B. All valves shall be mounted in such a position that valve position indicators are plainly visible when standing on the floor.

C. Ball valves with diameters ¼ to 4-inches for above ground installations shall be true union type. All below ground valve installations for valves 3-inches and smaller shall be solvent cement welded joint type.

D. Buried ball valves for chlorine solution shall be the appropriate model by Jamesbury as specified on the Civil Details Drawings (CZ).

E. For chlorine solution piping schedule 80 PVC pipe, the cement shall be Oatey Industrial Grade Low VOC Heavy Duty Gray, by Oatey Corp., Cleveland OH or engineer approved equal.

2.07 COMBINATION AIR RELEASE VALVES

A. This Section applies to all air release, air/vacuum, hydraulically operated air/vacuum valves, vacuum relief, combination air and air/vacuum or vacuum relief or similar valves.

B. Valves shall be supplied with shutoff gate or ball valves with operator handle or lever removed. Valves shall be properly vented and piped to drain.

C. Attention is directed to the requirement that valve's pressure rating be at least equal to the attached pipe's rating.

D. Valves shall be special non-clean water type Model D-020 or D-023 by A.R.I. with no equal.

E. Air/vacuum function of the valves shall be a slow-venting type, suitable for performance during a hydraulic transient.

F. The valves shall be of the special sewage type. The valve body and all metal components of the valve shall be Type 316 stainless steel. The valve float shall be constructed of

polycarbonate and Type 316 stainless steel. A valved outlet with hose connections for flushing water connection shall be provided.

## 2.08 HYDROSTATIC PRESSURE RELIEF VALVES

A. Hydrostatic pressure relief valves shall be similar and equal to Troy Cast Iron Pressure Relief Valve Model A2580 Wall Type, Waterman Industries, Inc. Model PRB-14, or approved equal. The pressure relief valve shall open with a minimum head difference of 6 inches of water.

B. Pressure relief valves shall have a solid cast bronze valve frame with machined sealing surfaces. The valve frame shall be of the flanged type with holes for mounting to an ANSI 125# standard flange or on the flat surface of a wall. Preferably, the valve shall mount to a cast iron wall sleeve which incorporates an integral waterstop that is cast into the wall section. The valve cover shall be solid cast bronze and incorporate a neoprene rubber seating surface mounted in a dovetail groove. Valve cover hinge arms shall be cast integrally with the cover and be attached to the frame using a stainless steel spring pin.

## 2.09 FLUSHING HYDRANTS

A. Flushing hydrants shall be of the non-freezing type with a 2-in hose nozzle and a 2-in FIP inlet. Flushing hydrants shall be set at the locations as shown in the Drawings and shall have a depth of bury that will meet the elevations given in the Drawing or a depth of 30 inches, whichever is greater. The hydrant shall have a locking operating rod, and shall be serviceable from above grade. Flushing hydrants shall be Eclipse Model No. 77 Mainguard Hydrant as manufactured by the Kupferle Foundry Company.

B. Caution signs shall be provided on each flushing hydrant connected to the plant water system. Signs shall be aluminum plate, suitable for outdoor applications. The signs shall be a minimum of 1/8-in thickness with black lettering on an OSHA Yellow background. Signs shall be mounted on a steel channel post. Signs shall have rounded corners, approximately 4-in by 7-in (4" x 7") with the following 3/4-in high letters: PLANT WATER - DO NOT DRINK.

## 2.10 YARD HYDRANTS

A. Yard hydrants shall be the non-freezing type with a 1-in inlet connection and a ¾" hose coupling adapter. Yard hydrants shall be set at the locations as shown in the Drawings and shall have a depth of bury that will meet the elevations given in the Drawings or depth of 30 inches, whichever is greater. Yard hydrants shall be Merrill Hi-Cap 1", Anyflow or approved equal. Yard hydrants shall include a brass anti-siphon vacuum breaker.

B. Caution signs shall be provided on each yard hydrant connected to the plant water system. Signs shall be aluminum plate, suitable for outdoor applications. The signs shall be a minimum of 1/8-in thickness with black lettering on an OSHA Yellow background. Signs shall be mounted on a steel channel post. Signs shall have rounded corners, approximately 4-in by 7-in (4" x 7") with the following 3/4-in high letters: PLANT WATER - DO NOT DRINK.

2.11 CORPORATION STOPS

A. Corporation stops shall be compliant with AWWA C800, and shall brass with Mueller-type threads, not less than 1-in in diameter and shall be installed where shown, specified or required.

B. Corporation stops shall be rated at 100 psig maximum working pressure for ½, ¾, and 1-in sizes, and at 80 psig maximum working pressure for 1-1/4, 1-1/2, and 2-in sizes. Furnish machined/ground key type corporation stops, as manufactured by the following:

1. The Figure H-10003 by Mueller Company of Decatur, Illinois; Model F800 by Ford Meter Box Company Inc. of Wabash, Indiana; Model 3121 by A.Y. McDonald Manufacturing Company of Dubuque, Iowa; or equal.

2.12 SURFACE PREPARATION AND SHOP COATINGS

A. The interior ferrous metal surfaces, except finished or bearing surfaces, shall be blast cleaned in accordance with SSPC SP-10 and painted with two coats of an approved two-component epoxy coating specifically formulated for potable water use. The coating shall be NSF certified to Standard 61.

B. Exterior ferrous metal surfaces of all buried valves and hydrants shall be blast cleaned in accordance with SSPC SP-6 and given two shop coats of an approved two-component coal tar epoxy paint.

C. Exterior ferrous metal surfaces of all non-buried valves shall be shop painted with one coat of primer in accordance with the requirements of Section 09901.

PART 3 EXECUTION

3.01 INSPECTION AND PREPARATION

A. During installation of all valves and appurtenances, verify that all items are clean, free of defects in material and workmanship and function properly.

B. All valves shall be closed and kept closed until otherwise directed by the Engineer.

3.02 INSTALLATION OF BURIED VALVES AND VALVE BOXES

A. Buried valves shall be cleaned and manually operated before installation. Buried valves and valve boxes shall be set with the stem vertically aligned in the center of the valve box. Valves shall be set on a firm foundation and supported by tamping pipe bedding material under the sides of the valve. The valve box shall be supported during backfilling and maintained in vertical alignment with the top flush with finish grade. The valve box shall be set so as not to transmit traffic loads to the valve.

B. Before backfilling, all exposed portions of any bolts shall be coated with two coats of bituminous paint.

C. Install valve floor stand operators with stainless steel bolts.

3.03 INSTALLATION OF TAPPING SLEEVES AND VALVES

A. The proper authority shall be contacted and their permission granted prior to tapping a "live" line. The required procedures and time table shall be followed exactly.

B. Installation shall be made under pressure and flow shall be maintained. The diameters of the tap shall be not less than 1/4-in less than the inside diameter of the branch line.

C. The entire operation shall be conducted by workers experienced in the installation of tapping sleeves and valves. The tapping machine shall be furnished by the Contractor.

D. Determine the location of the line to be tapped to confirm that the proposed location will be satisfactory and that no interference will be encountered such as joints or fittings. No tap or sleeve will be made closer than three feet from a pipe joint.

E. Tapping sleeve and valve with boxes shall be set squarely centered on the line to be tapped. Adequate support shall be provided under the sleeve and valve during the tapping operation. Thrust blocks or other permanent restraint acceptable to the Engineer shall be provided behind all tapping sleeves. Proper tamping of supporting pipe bedding material around and under the valve and sleeve is mandatory for buried installations.

F. After completing the tap, the valve shall be flushed to ensure that the valve seat is clean. All proper regulatory procedures (including disinfection) shall be followed exactly.

3.04 FIELD TESTS AND ADJUSTMENTS

A. Conduct a functional field test of each valve, including actuators and valve control equipment, in presence of Engineer to demonstrate that each part and all components together function correctly. All testing equipment required shall be furnished by the Contractor.

3.05 MANUFACTURER'S SERVICE

A. Furnish the services of a qualified representative of the tapping equipment manufacturer to provide on-site instruction during wet tapping of the existing water mains indicated on the Drawings.

B. Following installation of the butterfly valves, furnish the services of a qualified, factory trained representative of the manufacturer of the respective valves, to check the installations before they are placed in operation, supervise initial operations and testing in the presence of the Engineer, instruct the plant personnel in care and maintenance of the equipment, and make all necessary field adjustments. A minimum of one 8-hour day, which may not necessarily be consecutive, shall be provided for these services. In the event of trouble with the equipment, the representative of the respective manufacturer shall revisit the site as often as necessary until all troubles are corrected and the installation is entirely satisfactory.

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SECTION 02659

TEMPORARY BYPASS PUMPING SYSTEMS

PART 1 GENERAL

1.01 SCOPE OF WORK

A. Furnish all labor, materials, equipment and incidentals required and install, field test, and operate temporary by-pass pumping systems as proposed by the Contractor for the purpose of diverting flow around work areas as required by the provisions specified in Section 01810 Maintenance of Plant Operations and Sequence of Construction.

B. The design, installation and operation of temporary by-pass pumping systems shall be the Contractor's responsibility. The Contractor shall provide the services of a professional bypass company who can demonstrate to the Owner and Engineer that the company specializes in the design and operation of temporary by-pass pumping systems. The by-pass system shall meet the requirements of all codes and regulatory agencies having jurisdiction.

C. Maintain temporary by-pass pumping systems so that they are completely functional throughout the required period of service.

D. Following the required period of service, remove temporary by-pass pumping systems from site.

E. Provide all maintenance including manufacturer recommended preventive maintenance and on-call repair services. Contractor shall provide repair services and/or replacement equipment 24 hours per day, seven days per week within 4 hours of being called.

F. Should the Contractor elect to use diesel fuel for temporary by-pass pumping, the total storage quantity of fuel allowable at the plant site to operate the temporary pumps shall not exceed the sum of the individual fuel tank capacities furnished with each pump's diesel engine drive. Provide a refueling service to maintain continuous 24-hours per day, 7 days per week pumping system operation.

1.02 RELATED WORK

A. General Specifications are included in Section 01000.

B. Permits and Regulatory Requirements are specified in Section 01060.

C. Federal and State Requirements are specified in Section 01068.

D. Environmental Protection Procedures are specified in Section 01110.

E. Maintenance of Plant Operations and Sequence of Work is included in Section 01810.

F. Connections to and work on the Existing System is included in Section 02658.

1.03 SUBMITTALS

A. Submit, in accordance with Section 01300, the following:

1. A detailed description of each proposed temporary by-pass pumping system including pumps, pump drives, piping, hoses, valves, fittings, controls, wiring and any other related accessories required to provide a complete operating system in conformance with the requirements of this Section.

2. Detailed plans and sections showing the proposed pumping system layout including dimensions and elevations. Plan shall include but not be limited to the following:

   a. Staging area and access requirements for all pumps.

   b. Number, size, material, location and method of installation of suction piping.

   c. Number, size, material, location and method of installation of discharge piping.

   d. Pump size, capacity, number of units, diesel engine specifications, fuel tank capacity, fuel consumption requirements, and method of refueling.

   e. Calculations of static lift, pipe size selection, friction losses, flow velocity and pump selection.

   f. Pump curves showing pump operating range.

   g. Proposed method of freeze protection.

   h. Proposed method of noise control for each pump.

   i. Temporary pipe supports, anchorage, cover material and other accessories as required to stabilize the piping system.

   j. Installation schedule and maintenance schedule.

   k. Vendor phone number and pager number for 24-hour service.

   l. A minimum of five reference installations of projects with similar size in wastewater pumping applications. Include contact names and phone numbers.

   m. List of recommended spare parts to be stored on-site for emergency maintenance.

3. Provide information on the vendor's service staff capabilities and replacement parts inventory to show that the vendor has sufficient resources to provide emergency service and replacement equipment and/or parts to the Bucklin Point site within 4 hours of a service call.

4. A description of system operation and controls. Include a list of all alarm conditions and procedures for correcting problems including equipment replacement.

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5. A description and schedule for the proposed procedures for start up and testing of the facilities to demonstrate compliance with specified automatic operation and maintenance of a constant discharge pressure.

6. A plan of operations for inclement weather including snow storms. The plan shall demonstrate the ability to maintain pumping system operations throughout inclement weather events.

7. A description and schedule for the proposed procedures for dismantling the system, and restoring normal operations at the PCW.

1.04 REFERENCE STANDARDS

A. Design, manufacturing and assembly of elements of the equipment specified herein shall be in accordance with the following:

1. American Institute of Steel Construction (AISC)

2. American Iron and Steel Institute (AISI)

3. American Society of Mechanical Engineers (ASME)

4. American National Standards Institute (ANSI)

5. American Society for Testing Materials (ASTM)

6. American Welding Society (AWS)

7. American Bearing Manufacturers Association (ABMA)

8. Institute of Electrical and Electronics Engineers (IEEE)

9. National Electrical Manufacturers Association (NEMA)

10. Occupational Safety and Health Administration (OSHA)

11. Underwriters Laboratories (UL)

B. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.05 QUALITY ASSURANCE

A. The Contractor shall employ the services of a vendor who can demonstrate 5 years of recent and continuous specialization in the design, installation, operation and removal of temporary by-pass pumping systems in wastewater applications. The complete system shall be furnished from a single vendor who shall be capable of providing service staff, repair parts and replacement of any deficient system component within 4 hours of a service call, twenty-four hours per day, seven days per week.

1.06 SYSTEM DESCRIPTION

A. Where proposed by the Contractor, temporary by-pass pumping systems shall comply with specified requirements in Section 01810 Maintenance of Plant Operations and Sequence of Construction. Design flows shall be as specified in Section 01810.

B. Pumping system control panels shall be NEMA 4 and include flow indication, a flow totalizer, indicator lamps showing which pumps are operating, selector switch for auto or manual start and stop for each pump and visual and audible alarms for indication of operation failure and alarm conditions.

1.07 DELIVERY, STORAGE AND HANDLING

A. Delivery, storage and handling of equipment shall be as specified in (01 66 10) (01600).

1.08 MANUFACTURER'S SERVICES

A. Provide the services of the manufacturer's representative as specified herein.

B. Provide the services of the manufacturer's representative for physical checkout field testing and operation and maintenance instruction for a minimum of 1 person day per pumping system. See requirements in PART 3.

C. Provide the services of the manufacturer's representative or designated alternative, who shall be contactable 24-hours per day via telephone or pager and shall be available to be on site within 4 hours of being contacted at no additional cost to the Owner.

PART 2 PRODUCTS

2.01 GENERAL PUMPING EQUIPMENT

A. Furnish pumping units and all accessories from a single vendor. Each temporary by-pass pumping system shall be complete including pumps, drives, piping, piping headers, valves, flow meter, controls and appurtenances as required for a complete system.

B. The pumps, drives and controls shall be designed and built for 24-hour continuous service at any and all points within the required range of operation, without overheating, without cavitation, and without excessive vibration or strain. All parts shall be so designed and proportioned as to have the strength, stability and stiffness and be constructed to meet the specified requirements. Methods shall be provided for inspection, repairs, and adjustment.

C. All necessary foundation bolts, nuts, and washers shall be furnished.

D. Each piece of equipment shall be furnished with a nameplate (with embossed data) securely mounted to the body of the equipment. As a minimum, the nameplate for the pumps shall include the manufacturer's name and model number, serial number, rated flow capacity, head, speed and all other pertinent data. As a minimum, nameplates for drives shall include the manufacturer's name and model number, serial number, horsepower, speed, input voltage, amps, number of cycles and power and service factors.

E. Refer to Section 01000 for noise limitations for the equipment.

F. All equipment shall be suitable for outdoor operation under adverse weather conditions. Provide protection from freezing as required to maintain system operation.

G. Pumps shall be manufactured by Goodwin Pumps of America, Bridgeport NJ; Acme Dynamics, Plant City, FL; Thompson Pump and Manufacturing Co., Port Orange FL, or equal.

2.02 CONDITIONS OF OPERATION

A. Pumps shall be identical in every respect with all parts interchangeable.

B. Each pump shall be designed for the conditions of service specified in Section 01810. All pumps shall have a rising head capacity curve for stable pump operation from the minimum head operating point to the shut-off head.

| | |
|---|---|
| 1. Service: | Temporary By-Pass Pumping |
| 2. Number of pumps: | As required by the Application |
| 3. Liquid: | Treated Wastewater |
| 4. Design capacity total peak (gpm): | As required by the Application |
| 5. Type of drive | Diesel engine or Electric |

2.03 PUMPING SYSTEM COMPONENTS

A. All pumps shall be centrifugal, end suction, fully automatic self-priming units that do not require the use of foot-valves, vacuum pumps, diaphragm pumps, or isolation valves or float apparatus in the priming system.

B. Pump seals shall be high pressure, mechanical self-adjusting type with solid carbide faces capable of withstanding suction pressures to 100 psi without the pump running. The mechanical seal shall be cooled and lubricated in an oil bath reservoir, requiring no maintenance or adjustment. The oil bath reservoir shall not come in contact with or leak into the pumped water. Each pump shall be capable of running dry, with no damage for extended periods of time. All pump seal metal parts shall be stainless steel. All elastomers shall be Viton.

C. Each pump shall be driven by a diesel engine or electric motor. Diesel engine shall be water cooled. If the Contractor uses electric motor driven pumps, power costs are the responsibility of the Contractor as specified in Section 01000.

D. If using diesel driven pumps, each pump and diesel engine shall be skid mounted with integral fuel tank and skid lifting bracket.

E. Provide automatic start/stop controls for the pumping system to automatically maintain system flow within the flows specified in Section 01810. Controls shall be contained in a local control panel with provision to manually operate each pump, provide indication of pump operation, and indicate the total flow being pumped.

F. Provide all required suction and discharge pipe and fittings, discharge manifold pipe and fittings, shutoff valves, check valves, flow meter, pressure regulating valves, insulation, freeze protection, and all required accessories. All pipe and fittings shall be steel with flanged or quick connect

coupling connections, or high density polyethylene pipe with fused joints. All joints must be 100 percent restrained. Suction piping shall be rated for 25-in Hg vacuum. Discharge piping, fittings, connections, valves, and other discharge piping accessories shall be rated for a minimum working pressure of 150 psi.

PART 3 EXECUTION

3.01 INSTALLATION AND PHYSICAL CHECKOUT

A. Installation shall be in accordance with the system supplier's recommendations and approved shop drawing submittals.

B. Noise shall meet the requirements specified in Section 01100.

C. Install pumping units on a firm level surface.

D. Furnish the services of the pump system supplier's representative for a minimum of one day per temporary by-pass system to assist equipment installation and physical checkout.

3.02 FIELD TESTING

A. Provide field in accordance with the approved shop drawing submittal. Field tests shall demonstrate conformance with system requirements.

B. The Contractor shall require that field testing be conducted by the pump system supplier's representative in the presence of the Engineer. Furnish the services of the pump system supplier's representative for a minimum of one day per temporary by-pass system to conduct required testing.

C. Field testing shall demonstrate a minimum of 24 hours of continuous operation. During the 24 hours of continuous operation, the system shall demonstrate the ability to automatically start and stop pumps in response to changing flow conditions.

D. Remove and replace any system component that fails to perform in accordance with specified requirements.

3.03 SYSTEM OPERATION

A. Perform all required maintenance on the equipment to maintain the system integrity and capacity as specified.

B. Provide clean-up and disposal of contaminated material and reporting for all product spills.

3.04 EQUIPMENT REMOVAL

A. At the completion of the period of service, disconnect all temporary piping and remove all system components from the site. Restore the work site to its original condition.

END OF SECTION

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SECTION 02663

# WATER SERVICE CONNECTIONS

## PART 1 GENERAL

### 1.01 SCOPE OF WORK

A. Furnish all labor, materials, equipment and incidentals required in tapping and making house service connections where directed by the Engineer. Furnish all necessary labor and equipment to excavate the trenches from the main to the property line, backfill the trenches after the new connections are completed and restore the street and sidewalk to their original condition. Trench excavation and backfilling shall be done in accordance with all of the related Sections.

B. Corporation cocks shall be installed for connecting all service to the new water mains. Keep a record of the locations of all corporation cocks installed and shall indicate on the record those corporation cocks that have not been connected to service piping. A copy of this record shall be given to the Engineer at the completion of the work. Copper tubing, curb stops and necessary adapters shall be used to make connections between new corporation cocks and new and existing service piping. Unless otherwise directed, the new curb stops shall be located 1.5-ft back of the curb line. Be responsible for the removal and/or installation of curb stops in the locations directed by the Engineer.

C. All existing services shall be maintained until the new service connections have been fully installed to the satisfaction of the Engineer. All service connections shall then be made to the mains as specified below. Connect each existing house service to the new service connections provided after the completed installation has been accepted by the Engineer. All abandoned services shall have ends crimped.

### 1.02 RELATED WORK (NOT USED)

### 1.03 SUBMITTALS

A. Submit, in accordance with Section 01300, and within 10 days after signing the contract a list of materials to be furnished, the name of suppliers and the date of delivery of materials on the job site.

### 1.04 REFERENCE STANDARDS

A. American Society for Testing and Materials (ASTM)

1. ASTM B88 - Standard Specification for Seamless Copper Water Tube.

B. American Water Works Association (AWWA)

1. AWWA C800 - Underground Service Line Valves and Fittings.

C. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

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PART 2 PRODUCTS

2.01 MATERIALS

A. Service pipe shall be soft, annealed seamless copper tubing conforming to ASTM B88, Type K. The name and trademark of the manufacturer shall be stamped along the pipe.

B. Corporation stops for service connections shall have standard shop threads conforming to AWWA C800 on inlet end and with required joint or coupling for connection to copper pipe, A.Y. McDonald Mfg. Co., PA; James Jones Corp, CA or equal.

C. Curb stops shall be Water Works inverted-ground-key type, oval or round flow way, tee handle, without a drain. Pipe connections shall be suitable for the type of service pipe used. All parts shall be of bronze with female iron-pipe-size connections or compression-pattern flared tube couplings and shall be designed for a hydrostatic test pressure not less than 200 psi.

D. Service boxes shall be cast iron. Extension service boxes of the required length and having slide-type adjustment shall be installed at all service box locations. The boxes shall have housings of sufficient size to completely cover the service stop and shall be complete with identifying covers.

E. Adapter couplings for connecting new copper tubing to existing service connection at the property line shall be standard straight coupling fittings conforming to AWWA C800.

F. Line fittings, if required on new service line, shall be standard three-part unions conforming to AWWA C800.

PART 3 EXECUTION

3.01 INSTALLATION

A. Corporation cocks. The tapping machine shall be rigidly fastened to the pipe as near the horizontal diameter as possible. The length of travel of the tap should be so established that when the stop is inserted and tightened with a 14-in wrench, not more than one to three threads will be exposed on the outside. When a wet tapping machine is used, the corporation cock shall be inserted with the machine while it is still in place. Stops shall be tightened only sufficiently to give watertightness and care must be constantly exercised not to overtighten them.

B. Straight couplings. Install straight couplings to existing water mains of the sizes required in the locations designated by the Engineer in the field. Utilize the manufacturer's recommended installation procedures while performing the work. Care shall be taken to ensure a watertight connection.

C. Curb stops will, in most cases, be installed 1.5-ft from the curb line or pavement limit. Install the curb cocks and boxes in a workmanlike manner as described herein and as directed by the Engineer and shall place compacted screened gravel around and below the cock to permit ready draining of the pipe through the waste opening.

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D. The boxes shall be set in a true vertical position and if they are within the limits of the roadway or within limits where the plowing of snow will take place in the winter, the tops of the boxes shall be set about 1/2-in below the top of the finished grade. In locations where these boxes are not likely to be disturbed, the tops shall be set flush with the adjoining ground.

E. Copper tubing. Care shall be exercised in the placing and laying of copper tubing to be sure that the pipe does not have kinks or sharp bends and to assure against it being in contact with sharp stones or ledge which would cause damage to the pipe. At least 6-in of selected fill shall be placed adjacent to and above the pipe and no stone shall be placed over the pipe until the depth of backfill above the latter is in excess of 1-ft.

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SECTION 02930

SEEDING FOR SITE RESTORATION

PART 1 GENERAL

1.01 SCOPE OF WORK

A. Furnish all labor, materials, equipment and incidentals; place topsoil; finish grade; and apply lime, fertilizer, seed, mulch and water on all areas that have been disturbed by construction work.

1.02 RELATED WORK

A. Section 01011 – Site Conditions.

B. Section 02100 – Site Preparation.

1.03 COORDINATION

A. Completely coordinate the work of this Section with the work of other sections. Verify at the site both the dimensions and work of other trades adjoining items of work in this Section before commencement of items herein specified.

B. Furnish to the pertinent trades all items included under this Section that are to be built into the work of other sections.

1.04 FIELD MEASUREMENTS

A. Take field measurements at the site to verify or supplement indicated dimensions and to ensure proper coordination of all other construction items.

1.05 SUBMITTALS

A. Submit material and equipment furnished under this Section including seed mixtures and product label information in accordance with Section 01300. Seed certificates shall include guaranteed percentages of purity, weed content, and germination, and shall indicate the net weight and date of shipment. No seed shall be sown until the certificates have been submitted.

B. Submit samples of all materials for inspection and acceptance upon request by the Engineer.

PART 2 PRODUCTS

2.01 MATERIALS

A. Topsoil shall be fertile, natural soil, typical of the locality, free from large stones, roots, sticks, clay, peat, weeds and sod, and obtained from naturally drained areas. It shall not be excessively acid or alkaline nor contain toxic material harmful to plant growth.

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B. Lime shall be agricultural grade ground limestone or approved equivalent, containing not less than 85% calcium and magnesium carbonates.

C. Fertilizer shall be a commercial grade, 10-20-10, uniform in composition, suitable for application with mechanical equipment, and conforming to State fertilizer laws. Deliver fertilizer to the site in original, unopened containers, bearing the name, trademark and manufacturer's guaranteed analysis. Store fertilizer so that it remains dry and free flowing.

D. The seed shall be labeled in accordance with current rules and regulations of the Arkansas State Plant Board and shall have a minimum of 98% pure seed and 85% germination by weight and shall contain no more than 1% weed seeds. A combined total of 50 noxious weed seeds shall be the maximum amount allowed per pound of seed with the following exceptions: Johnson grass seed, wild onion seed, wild garlic seed, field bindweed seed or nut grass seed will not be allowed in any amount whatsoever. Deliver seed in original, unopened containers, bearing the name, trademark and warranty of the producer. Seed that has become wet, moldy or otherwise damaged in transit or in storage will not be acceptable.

E. Mulch cover shall consist of straw from threshed rice, oats, wheat, barley or rye; of wood excelsior; or from hay obtained from various legumes or grasses, such as lespedeza, clover, vetch, soybeans, bermuda, carpet sedge, bahia, fescue, or a combination thereof. Mulch shall be dry and reasonably free from Johnson grass or other noxious weeds and shall not be excessively brittle or in an advanced state of decomposition. All material will be inspected and approved prior to use.

F. Hydraulically applied mulch shall be a specially processed cellulose fiber containing no growth or germination-inhibiting factors. It shall be manufactured in such a manner that after addition and agitation in slurry tanks with water, the fibers in the material become uniformly suspended in a homogenous slurry. When sprayed on the ground, the material shall allow adsorption and percolation of moisture. Each package of cellulose fiber shall be marked by the manufacturer to show the air dry weight content.

G. Water shall be of irrigation quality and free of impurities that would be detrimental to plant growth.

## PART 3 EXECUTION

### 3.01 GENERAL

A. Seeding shall consist of furnishing and applying seed, mulch, water, and fertilizer on all areas that have been disturbed by the construction work. These areas shall include lawns, pastures, ditches, ditch banks, embankment areas, compacted fill areas, cut or fill slopes and any area disturbed by construction.

B. Perform seeding, mulching and conditioning only during those periods within the season that are normal for such work as determined by the weather and locally accepted practice, as approved by the Engineer. Hydroseed only on calm days.

C. Submit schedules for seeding and fertilizing to the Engineer for approval prior to the work.

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3.02 APPLICATION

A. Unless otherwise shown on the Drawings, place topsoil to a minimum depth of 4-in.

B. For all areas to be seeded:

1. Obtain soil samples, to a depth of five inches (5"), from each major soil area, and have a lime requirement analysis conducted. Apply lime at the rate determined by the requirement test.

2. Apply fertilizer at a rate of 800 pounds per acre.

3. Apply grass seed, composed of the following varieties (premixed), at the following rates:

| | | |
|---|---|---|
| a. Spring, Summer & Fall | Bermuda-Common-Hulled | 10 lbs/acre |
| b. Fall | Bermuda-Common-Unhulled | 10 lbs/acre |
| c. Spring, Summer & Fall | Red Fescue | 20 lbs/acre |
| d. Spring & Fall | Annual Rye | 30 lbs/acre |

4. Apply mulch cover at a rate of 4,000 pounds per acre.

C. The application of fertilizer and lime may be performed hydraulically in one operation with hydroseeding and mulching. If lime is applied in this manner, clean all structures and paved areas of unwanted deposits.

3.03 INSTALLATION

A. Seed Bed Preparation

1. Remove and dispose of off-site all excess dirt, construction materials, trees, rubbish, debris, roots and stumps. Rake to loosen the subgrade immediately prior to the application of topsoil and remove all rubbish, sticks, roots and stones larger than 2-in. Subgrade shall be inspected and approved by the Engineer before topsoil is placed.

2. Place topsoil over approved areas to a depth sufficiently greater than required so that after natural settlement and light rolling, the complete work will conform to the lines, grades and elevations shown on the Drawings or as directed by the Engineer. Do not spread topsoil in water or while frozen or muddy.

3. Uniformly spread lime and then thoroughly pulverize the seedbed by means of disk harrows, hand raking, or other approved methods, thoroughly mixing lime and soil to a depth of four inches (4"). Remove rocks, large clods, lumps, brush, roots, litter, and other objectionable foreign matter turned up during mixing, and apply water in order to maintain the desired moisture content in the soil. Follow disk harrowing with a spiked-tooth harrow to provide a finer surface texture.

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B. Fertilizing

1. Apply fertilizer uniformly and incorporate it into the soil to a depth of at least two inches (2"). Fertilizer may be worked into the soil alone or in conjunction with the required lime. The fertilizer may be broadcasted, drilled into the soil or combined with the seed in the hydroseeding operation.

2. Roll the prepared surface with a hand roller weighing not more than 100-pounds per ft. of roller width (100 lbs/ft). Refill with additional topsoil and regrade all depressions caused by settlement during rolling.

C. Seeding

1. Place seed either by broadcasting, drilling or by hydroseeding, and within ten (10) days following soil preparation. When the seed is drilled, it shall be in rows parallel to the toe of the slope. Drills shall not be more than six inches (6") apart. Fertilizer and seed shall not be drilled together.

2. If a hydroseeder is used, fertilizer and seed may be incorporated into one operation, but a maximum of 800 pounds of fertilizer shall be permitted per each 1,500 gallons of water. The area shall be lightly compacted with a cultipacker immediately prior to hydroseeding. Prior to the start of work, furnish the Engineer for approval a certified statement as to the number of pounds of materials to be used per 100 gallons of water. This statement shall also specify the number of square feet of seeding that can be covered with the quantity of solution in the hydroseeder.

D. Mulching

1. Immediately after seeding, spread mulch uniformly over the entire area by approved power mulching equipment. Mulch shall be anchored or otherwise stabilized to hold the mulch in place until the seedbed has germinated. Asphalt may not be used as an anchoring agent. Mulch that is windblown or otherwise disturbed shall be replaced and the excess shall be promptly removed from the site.

E. Water

1. After application of the mulch cover, apply water in sufficient quantity to thoroughly moisten the soil to a depth of pulverization and as necessary to germinate the seed and maintain growth at the direction of the Engineer for a period of at least three (3) weeks. The time required for application of water will not be included in the computations of contract time for completion of the project provided all other work under the contract has been completed.

2. Water used in the seeding operation will not be furnished by the Owner. The Contractor must make provision to obtain water for this operation at his own expense.

3.04 SEEDING IN WOODED AND UNGRADED AREAS

A. For preparation and seeding in wooded areas under this Contract and where no grading is required, all of the specified materials and procedures shall be utilized except that no disking

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shall be performed within the drip line of trees to be preserved. The seed bed shall be prepared by the addition of a thin layer of top soil roughly 1-in deep.

3.05 CLEANUP

A. Prior to final acceptance and payment, the Contractor shall remove all machinery, equipment, surplus materials, rubbish, etc., from the project. Pavement, driveways, sidewalks, and storm drainage facilities shall be cleaned and all soils or other debris removed.

3.06 MAINTENANCE AND PROVISIONAL ACCEPTANCE

A. Keep all seeded areas watered and in good condition, reseeding if and when necessary until a good, healthy, uniform growth is established over the entire area. Maintain these areas in an approved condition including a minimum of two (2) mowings of the all seeded and restored areas until provisional acceptance.

B. Provide against washouts on slopes by an approved method. Any washout that occurs shall be regraded and reseeded at the Contractor's expense until a good sod is established.

C. The Engineer will inspect all work for provisional acceptance at the end of the eight (8) week grass maintenance period, upon the written request, received at least ten (10) days before the anticipated date of inspection.

D. A satisfactory stand of grass will be defined as a section of grass of 10,000 sq.-ft. or larger that has:

1. No bare spots larger than 3 sq.-ft.

2. No more than 10 percent of total area with bare spots larger than 1 sq.-ft.

3. Not more than 15% of total area with bare spots larger than 6-in. square.

E. Furnish full and complete written instructions for maintenance of the seeded and restored areas to the Owner at the time of provisional acceptance.

F. The inspection by the Engineer will determine whether maintenance shall continue in any area of manner.

G. After all necessary corrective work and clean-up has been completed and maintenance instructions have been received by the Owner, the Engineer will certify in writing the provisional acceptance of the seeded and restored areas. Maintenance of seeded and restored areas shall cease on receipt of provisional acceptance, except that the Contractor shall groom and mow all restored areas immediately prior to Final Acceptance by the Owner.

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# DIVISION 3

# CONCRETE

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# SECTION 03100

# CONCRETE FORMWORK

## PART 1: GENERAL

### 1.01 SCOPE OF WORK

A. Furnish all labor, materials, equipment and incidentals required and design, install and remove formwork for cast-in-place concrete complete as shown on the Drawings and as specified herein.

B. Secure to forms or set for embedment all miscellaneous metal items, sleeves, reglets, anchor bolts, inserts, waterstops, hatches and other items furnished under other Sections and required to be cast into concrete.

### 1.02 RELATED WORK

A. Concrete reinforcement is included in Section 03200.

B. Concrete joints and joint accessories are included in Section 03250.

C. Cast-in-place concrete is included in Section 03300.

D. Concrete finishes are included in Section 03350.

E. Grout is included in Section 03600.

F. Modifications to existing concrete are included in Section 03740.

G. Concrete electrical raceway encasement is included in Section 03800.

H. Miscellaneous metals are furnished under Sections 05500 and 05510.

I. Anchor bolts for equipment are furnished under Divisions 11, 13, 14, 15 and 16.

### 1.03 SUBMITTALS

A. Submit, in accordance with Section 01300, shop drawings and product data showing materials of construction and details of installation for:

1. Form release agent

2. Form ties

3. Location and sequence of concrete placement.

B. Review will be for appearance, performance and strength of the completed structure only. Approval by the Engineer will not relieve the Contractor of responsibility for the strength,

safety or correctness of methods used; the adequacy of equipment; or from carrying out the work as shown on the Drawings and as specified herein.

C. Sample Substrate

1. Demonstrate to the Engineer on a designated area of the concrete substructure exterior surface that the form release agent will not impair the bond of paint, sealant, waterproofing, dampproofing, or other coatings and will not affect the forming materials.

D. Certificates

1. Submit completed PE Certification Form for design of formwork in accordance with Section 01300. The PE Certification Form shall be completed and stamped by a professional engineer licensed in the State of Arkansas.

2. Certify that form release agent complies with Federal, State and local VOC limitations.

1.04 REFERENCE STANDARDS

A. American Concrete Institute (ACI)

1. ACI 301 - Specifications for Structural Concrete

2. ACI 350 – Environmental Concrete Structures

3. ACI 347 - Guide to Formwork for Concrete

B. APA - The Engineered Wood Association (APA)

1. Material grades and designations as specified

C. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.05 SYSTEM DESCRIPTION

A. Definitions:

1. Architectural concrete is defined as concrete for the following exposed reinforced concrete surfaces where architectural concrete is indicated on the Drawings:

a. Exterior: walls to 6-in below finish grade, beams, columns and underside of slabs.

b. Interior: walls, beams, columns and underside of slabs visible in the finished structures.

c. Open topped tanks to 1-ft below normal operating water level: Walls, beams, columns and underside of slabs.

2. Structural concrete is defined as concrete that is not architectural concrete.

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B. Structural design responsibility: Contractor shall provide all forms and shoring designed by a professional engineer licensed in the State of Arkansas. Design and erect formwork in accordance with the requirements of ACI 301, ACI 350, and ACI 347. Comply with all applicable regulations and codes. Consider any special requirements due to the use of plasticized and/or retarded set concrete.

## PART 2: PRODUCTS

### 2.01 GENERAL

A. The usage of a manufacturer's name and model or catalog number is for the purpose of establishing the standard of quality and general configurations desired.

### 2.02 MATERIALS

A. Forms, General

1. Make forms for cast-in-place concrete of wood, steel or other approved materials, except as specified in Paragraphs 2.02B and 2.02C.2. Construct wood forms of sound lumber or plywood free from knotholes and loose knots. Construct steel forms to produce surfaces equivalent in smoothness and appearance to those produced by new plywood panels. Design and construct all forms to provide a flat, uniform concrete surface requiring no grinding, repairs, or finishing except as specified in Section 03350.

B. Forms for Exposed Concrete

1. Make forms for all exposed and non-submerged exterior and interior concrete of new and unused Plyform exterior grade plywood panels manufactured in compliance with the APA and bearing the APA trademark. Provide B grade or better veneer [with High Density Overlay] on all faces to be in contact with concrete. Design and construct all forms to provide a flat, uniform concrete surface requiring no grinding, repairs, or finishing except as specified in Section 03350.

2. Provide rigid forms that will not deflect, move, or leak. Design forms to withstand the high hydraulic pressures resulting from rapid filling of the forms and heavy high frequency vibration of the concrete. Limit deflection to 1/400 of each component span. Lay out form joints in a uniform pattern.

3. Dress and match boards. Sand plywood smooth and fit adjacent panels with tight joints. Tape, gasket, plug, and/or caulk all joints and gaps in forms to provide watertight joints that will withstand placing pressures without exceeding specified deflection limit or creating surface patterns.

4. Provide ¾-inch chamfer on all corners unless otherwise indicated.

5. Provide forms for circular structures that conform to the circular shape of the structure and where applicable the existing structure below. Straight panels may be substituted for circular panels if the straight panels do not exceed two feet in width, nor deflect more than 3-1/2 degrees per joint, nor conflict with specific notes indicated and panels conform to the existing structure below.

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C. Column Forms

1. Form rectangular columns as specified for exposed concrete. Provide 3/4-inch chamfer on all corners unless otherwise indicated.

2. Form circular columns with steel, fiberglass reinforced plastic or seamless cardboard column forms. Provide continuous forms for the height of the column between construction joints indicated.

D. Provide rustications as indicated. Mill and plane smooth moldings for chamfers and rustications. Provide rustications and chamfer strips of nonabsorbent material, compatible with the form surface and fully sealed on all sides to prevent the loss of paste or water between the two surfaces.

E. Form Release Agent. Coat all form surfaces in contact with concrete with an effective, non-staining, non-residual, water based, bond-breaking form coating unless otherwise indicated or specified. Form release agent shall not impair the bond of paint, sealant, waterproofing, dampproofing or other coatings.

F. For concrete surfaces which are to be painted, use forms with high density overlay or a similar material which does not require a form release agent unless the Contractor can substantiate to the satisfaction of the Engineer that the form release agent will not remain on the formed surface after it is stripped.

G. Form Ties

1. Coil and Wire Ties: Provide ties manufactured so that, after removal of the projecting part, no metal remains within 1-1/2-inches of the face of the concrete. The part of the tie to be removed shall be at least 1/2-inch diameter or be provided with a plastic or wooden cone at least 1/2-inch diameter and 1-1/2-inch-long. Provide cone washer type form ties in concrete exposed to view.

2. Flat Bar Ties for Panel Forms: Provide ties that have plastic or rubber inserts with a minimum depth of 1-1/2-inches and manufactured to permit patching of the tie hole.

3. Provide ties for liquid retaining structures and exterior below grade basement walls that have a steel waterstop tightly attached to each strut or that have a neoprene rubber washer on each strut.

4. Do not use common wire for form ties.

5. Alternate form ties consisting of tapered through-bolts at least 1 inch in diameter at smallest end or through-bolts that utilize a removable tapered sleeve of the same minimum size may be used. Install in forms so that large end is, where applicable, on the liquid or backfilled side of the wall. Clean, fill and seal form tie hole with non-shrink cement grout to provide watertight form tie holes and make all repairs needed to make watertight.

6. Alternate form ties specified in Paragraph 2.02I.5 may be used when forms are to be set against previously placed or existing concrete walls. Use in conjunction with cast-in threaded inserts or drilled-in threaded anchors so that no metal remains within expansion

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joint upon removal of tapered through bolt. Conform to requirements specified in Paragraph 2.02I.5.

PART 3: EXECUTION

3.01 GENERAL

A. Provide forms for all cast-in-place concrete including sides of footings. Construct and place forms to provide concrete of the shape, lines, dimensions and appearance indicated.

B. Provide removable panels at the bottom of forms for walls and columns to allow cleaning, inspection and joint surface preparation. Provide closable intermediate inspection ports in forms for walls. Provide tremies and hoppers for placing concrete and to allow concrete sampling, prevent segregation and prevent the accumulation of hardened concrete on the forms and reinforcement above the fresh concrete.

C. Place molding, bevels, or other types of chamfer strips to produce blockouts, rustications, or chamfers as indicated on the Drawings or as specified herein. Provide chamfer strips at horizontal and vertical projecting corners to produce a 3/4-inch chamfer. Provide rectangular moldings at locations requiring sealants where shown on the Drawings or specified herein.

D. Provide rigid forms to withstand construction loads and vibration and meeting specified deflection limits and tolerances. Construct forms so that the concrete will not be damaged by form removal.

E. Accessories which remain embedded in the concrete after formwork removal will be subject to the approval of the Engineer. Permanent embedments shall have sufficient concrete cover or be of suitable materials for the exposure condition as approved by the Engineer. Remove unsatisfactory embedded items at no additional cost to the Owner.

3.02 FORM TOLERANCES

A. Design, construct and surface forms in accordance with ACI 347 and meet the following additional requirements for the specified finishes.

B. Forms for Exposed Concrete: Edges of all form panels in contact with concrete flush within 1/8 inch and forms for plane surfaces plane within 1/8 inch in 4 ft. Maximum deviation of the finished surface at any point not to exceed 1/4 inch from the intended surface indicated. Arrange form panels symmetrically and orderly to minimize the number of seams. Provide tight forms to prevent the passage of mortar, water, and grout.

C. Formed Surface Not Exposed to View or Buried: Class "C" Surface per ACI 347.

D. Formed Surface Including Mass Concrete, Pipe Encasement, Electrical Raceway Encasement and Other Similar Installations: No minimum requirements for surface irregularities and surface alignment. The overall dimensions of the concrete shall be plus or minus 1 inch from the intended surface indicated.

E. Formed Surfaces to be Painted: Surface irregularities limited to 1/16 inch at any point. Variation in alignment not to exceed 1/16 inch per 4 ft. The maximum deviation of the finish surface at any point not to exceed 1/4 inch from the intended surface indicated.

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3.03 FORM PREPARATION

A. Clean, repair, remove projecting nails and fill holes, and smooth protrusions on all form surfaces to be in contact with concrete before reuse. Do not reuse forms for exposed concrete unless a "like new" condition of the form is maintained that will produce surfaces equivalent in smoothness and appearance to those produced by new plywood panels.

B. Coat wood forms in contact with concrete using form release agent prior to form installation.

C. Clean steel forms by sandblasting or other method to remove mill scale and other ferrous deposits from the contact surface of all forms. Coat steel forms in contact with concrete using form release agent prior to form installation.

3.04 REMOVAL OF FORMS

A. Be responsible for all damage resulting from removal of forms and make repairs at no additional cost to the Owner. Leave in place forms and shoring for horizontal structural members in accordance with ACI 301 and ACI 347. Conform to the requirements for form removal specified in Section 03300.

3.05 INSPECTION

A. Notify the Engineer when the forms are complete and ready for inspection, at least six working hours prior to the proposed concrete placement. The Engineer will inspect the forms to ensure overall conformance with the contract documents.

B. Failure of the forms to comply with the requirements specified, or to produce concrete complying with requirements specified shall be grounds for rejection of that portion of the concrete work. Repair or replace rejected work as directed by the Engineer at no additional cost to the Owner. Such repair or replacement shall be subject to the requirements of these Specifications and approval of the Engineer.

END OF SECTION

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SECTION 03200

CONCRETE REINFORCEMENT

PART 1: GENERAL

1.01 SCOPE OF WORK

A. Furnish all labor, materials, equipment and incidentals required and install all concrete reinforcement complete as shown on the Drawings and as specified herein, including dowels embedded into concrete for masonry.

1.02 RELATED WORK

A. Concrete formwork is included in Section 03100.

B. Concrete joints and joint accessories are included in Section 03250.

C. Cast-in-place concrete is included in Section 03300.

D. Grout is included in Section 03600.

E. Modifications to existing concrete are included in Section 03740.

F. Concrete electrical raceway encasement is included in Section 03800.

1.03 SUBMITTALS

A. Submit, in accordance with Section 01300, shop drawings and product data showing materials of construction and details of installation for:

1. Reinforcing steel. Drawings for fabrication, bending, and placement of concrete reinforcement shall conform to the recommendations of ACI 315 for placement drawings and as specified herein.

a. Placement drawings. For walls, show elevations from the outside, looking towards the structure, at a minimum scale of 1/4-in. to one foot. For slabs, show top and bottom reinforcement on separate plan views, as needed for clarity. For beams and columns, show schedules with sections and/or elevations and stirrup/tie spacing. Show additional reinforcement around openings, at corners and at other locations indicated, diagrams of bent bars, arrangements and assemblies, all as required for the fabrication and placement of concrete reinforcement. Reference bars to the same identification marks shown on the bar bending details. Identify bars to have special coatings and/or to be of special steel or special yield strength.

b. Bar bending details. Reference bars to the same identification marks shown on the placement drawings. Identify bars to have special coatings and/or to be of special steel or special yield strength.

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2. Fiber reinforcement. Submit manufacturer's data for synthetic reinforcing fibers. Identify all placements that are to contain synthetic reinforcing fibers. The fiber length and amount of fibers per cubic yard to be used for each placement shall be noted. Submit two samples of synthetic reinforcing fibers.

B. Submit samples of each of the following items.

1. Two samples of each type of mechanical reinforcing steel coupling system.

C. Submit, in accordance with Section 01300, Test Reports of each of the following items.

1. Certified copy of mill test on each heat of each steel proposed for use showing the physical properties of the steel and the chemical analysis.

2. Welder's certification in accordance with AWS D1.4 when welding of reinforcement is indicated, specified, or approved.

1.04 REFERENCE STANDARDS

A. American Society for Testing and Materials (ASTM)

1. ASTM A82 - Standard Specification for Steel Wire, Plain, for Concrete Reinforcement.

2. ASTM A184 - Standard Specification for Welded Deformed Steel Bar Mats for Concrete Reinforcement.

3. ASTM A185 - Standard Specification for Steel Welded Wire Fabric, Plain, for Concrete Reinforcement.

4. ASTM A496 - Standard Specification for Steel Wire, Deformed, for Concrete Reinforcement.

5. ASTM A497 - Standard Specification for Steel Welded Wire Fabric, Deformed, for Concrete Reinforcement.

6. ASTM A615 - Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.

7. ASTM A704 - Standard Specification for Welded Steel Plain Bar or Rod Mats for Concrete Reinforcement.

8. ASTM A706 - Standard Specification for Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement.

B. American Concrete Institute (ACI)

1. ACI 301 - Specifications for Structural Concrete.

2. ACI 315 - Details and Detailing of Concrete Reinforcement.

3. ACI 350 - Code Requirements for Environmental Concrete Structures.

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4. SP-66 (ACI 315) ACI Detailing Manual.

C. Concrete Reinforcing Steel Institute (CRSI)

1. Manual of Standard Practice

D. American Welding Society (AWS)

1. AWS D1.4 Structural Welding Code - Reinforcing Steel

E. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.05 QUALITY ASSURANCE

A. Fiber Reinforcement. Provide services of a manufacturer's representative, with at least 2 years experience in the use of the synthetic reinforcing fibers for a preconstruction meeting and assistance during the first placement of the material.

1.06 DELIVERY, HANDLING AND STORAGE

A. Provide reinforcement free from mill scale, rust, mud, dirt, grease, oil, ice, or other foreign matter.

B. Ship and store reinforcement with bars of the same size and shape fastened in bundles with durable tags, marked in a legible manner with waterproof markings showing the same "mark" designations as those shown on the submitted placement drawings. Tags for ASTM A706 reinforcing and for ASTM A615 reinforcing meeting the requirements of Paragraph 2.01C.1 shall indicate that the reinforcing is weldable.

C. Store reinforcement off the ground, protect from moisture and keep free from rust, mud, dirt, grease, oil, ice, or other injurious contaminants.

PART 2: PRODUCTS

2.01 MATERIALS

A. Provide new materials of domestic manufacture complying with the following material specifications.

B. Deformed Concrete Reinforcing Bars: ASTM A615, Grade 60 deformed bars.

C. Deformed Concrete Reinforcing Bars required on the Drawings to be Field Bent or Welded ASTM A706.

1. ASTM A615, Grade 60 may be substituted for ASTM A706 subject to the following:

a. The actual yield strength of the reinforcing steel based on mill tests does not exceed the specified yield strength by more than 18,000 psi. Retests not to exceed this value by more than an additional 3,000 psi.

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b. The ratio of the actual ultimate tensile strength to the actual tensile yield strength of the reinforcement is not less than 1.25.

c. The carbon equivalency (CE) is 0.55 percent or less.

D. Spiral Reinforcement

1. ASTM A615, Grade 60 for plain or deformed bars.

2. ASTM A82 for cold-drawn wire.

E. Welded Steel Wire Fabric: ASTM A185. Provide in flat sheets.

F. Welded Deformed Steel Wire Fabric: ASTM A497.

G. Welded Plain Bar Mats: ASTM A704 and ASTM A615 Grade 60 plain bars.

H. Fabricated Deformed Steel Bar Mats: ASTM A184 and ASTM A615 Grade 60 deformed bars.

I. Reinforcing Steel Accessories

1. Plastic Protected Wire Bar Supports: CRSI Bar Supports, Class 1 - Maximum Protection.

2. Stainless Steel Protected Wire Bar Supports: CRSI Bar Supports, Class 2 - Moderate Protection with legs made wholly from stainless steel wire.

3. Precast Concrete Bar Supports: CRSI Bar Supports, Precast Concrete Bar Supports. Precast concrete blocks that have equal or greater strength than the surrounding concrete.

J. Tie Wire

1. Tie Wires for Reinforcement: 16-gauge or heavier black annealed wire.

K. Mechanical Reinforcing Steel Coupling System

1. Use only where indicated. Mechanical reinforcing steel coupling system shall be positive connecting taper threaded type employing a hexagonal coupler such as Lenton rebar splices as manufactured by Erico Products Inc., Solon, OH or equal. Coupling system shall meet all ACI 318 requirements. Bar ends must be taper threaded with coupler manufacturer's bar threader to ensure proper taper and thread engagement. Provide with cap on female end to exclude dirt, debris and wet concrete. Couplers shall be torqued to manufacturer's recommended value.

2. Unless otherwise noted on the Drawings, mechanical reinforcing steel coupling system shall produce a splice strength in tension or compression of not less than 125 percent of the ASTM specified minimum yield strength of the reinforcing bar. Base yield strength on Grade 60 reinforcing unless otherwise indicated or specified.

3. Compression type mechanical splices shall provide concentric bearing from one bar to the other bar.

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L. Fiber Reinforcement

1. Synthetic reinforcing fibers for concrete grout shall be 100 percent polypropylene collated, fibrillated fibers, Fibermesh 300 as manufactured by Propex Concrete Systems Corp, Chattanooga, TN, or equal. Fiber length and quantity for the concrete grout mix shall be in strict compliance with the manufacturer's recommendations as approved by the Engineer.

2.02 FABRICATION

A. Comply with the CRSI Manual of Standard Practice.

B. Bend bars cold. Do not straighten or re-bend bars.

C. Bend bars around a revolving collar having a diameter not less than that recommended by the CRSI or ACI 318.

D. Saw cut bar ends that are to be butt spliced, placed through limited diameter holes in metal, or threaded. Terminate saw cut ends in flat surfaces within 1-1/2 degrees of a right angle to the axis of the bar.

E. Spirals

1. Provide a minimum of 1-1/2 finishing turns at the top and bottom.

2. Splices. Provide tension lap splices at least 48 bar diameters, but not less than 12 inches in length. Do not use welded splices unless specifically approved by the Engineer.

3. Provide spacers as recommended by the CRSI.

PART 3: EXECUTION

3.01 INSTALLATION

A. Comply with the CRSI Manual of Standard Practice for surface condition, bending, spacing and tolerances of placement for reinforcement. Provide the amount of reinforcing indicated at the spacing and clearances indicated on the Drawings.

B. Determine clear concrete cover based on exposure to the environment. Unless indicated otherwise on the Drawings, provide the following minimum clear concrete cover over reinforcement:

1. Concrete cast against and permanently exposed to earth: 3-inch

2. Concrete exposed to soil, water, sewage, sludge and/or weather:

a. Slabs (top and bottom cover), walls: 2-inch

b. Beams and columns (ties, spirals and stirrups): 2-inch.

3. Concrete not exposed to soil, water, sewage, sludge and/or weather:

a. Slabs (top and bottom cover), walls, joists, shells and folded plate members: 1-inch

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b. Beams and columns (ties, spirals and stirrups): 1-1/2-inch

C. Coat uncoated reinforcement which will be exposed for more than 60 days after placement with a heavy coat of neat cement slurry.

D. Do not weld reinforcing steel bars either during fabrication or erection unless indicated on the Drawings or as specified herein, or unless prior written approval has been obtained from the Engineer. Remove immediately all bars that have been welded, including tack welds, without such approval. Comply with AWS D1.4 when welding of reinforcement is shown on the Drawings, specified, or approved.

E. Reinforcing steel interfering with the location of other reinforcing steel, piping, conduits or embedded items may be moved within the specified tolerances or one bar diameter, whichever is greater. Obtain the approval of the Engineer if greater displacement of bars to avoid interference is needed. Do not cut reinforcement to install inserts, conduits, mechanical openings or other items without the prior approval of the Engineer.

F. Secure, support and tie reinforcing steel to prevent movement during concrete placement. Secure dowels in place before placing concrete.

G. Do not field bend reinforcing unless indicated or specifically authorized in writing by the Engineer. Cold-bend bars indicated or authorized to be field bent around the standard diameter spool specified in the CRSI. Do not heat bars. Closely inspect the reinforcing steel for breaks. Replace, repair by cutting out damaged bars and splicing new bars using coupling sleeves filled with ferrous material, or otherwise repair damaged reinforcing bars as directed by the Engineer at no additional cost to the Owner. Do not bend reinforcement after it is embedded in concrete unless indicated on the Drawings.

## 3.02 REINFORCEMENT AROUND OPENINGS

A. Provide additional reinforcing steel on each side of the opening equivalent to one half of the cross-sectional area of the reinforcing steel interrupted by the opening unless indicated otherwise on the Drawings. Extend each end of each bar beyond the edge of the opening or penetration by the tension development length for that bar size.

## 3.03 SPLICING OF REINFORCEMENT

A. Provide splices as shown on the Drawings and as specified herein.

B. Splices Indicated as Compression Splices: Provide lap splice of 30 bar diameters, but not less than 12 inches unless indicated otherwise on the Drawings. Base the lap splice length for column vertical bars on the bar size in the column above.

C. All Other Splices: Provide tension lap splices in compliance with ACI 350. Stagger splices in adjacent bars where possible. Provide Class B tension lap splices at all locations unless otherwise indicated.

D. Splices in Circumferential Reinforcement in Circular Walls: Provide Class B tension lap splices and stagger as indicated.

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E. Tension Members: Avoid splicing of reinforcing steel in concrete elements indicated as "tension members." However, if splices are required for constructability, splices in the reinforcement subject to direct tension shall be butted and joined with complete penetration welds to develop, in tension, at least 125 percent of the specified yield strength of the bar. Offset splices in adjacent bars the distance of a Class B splice or 30-in, whichever is greater.

F. Lap splices in welded wire fabric in accordance with the requirements of ACI 318 but not less than 12 inches. Tie the spliced fabrics together with wire ties spaced not more than 24 inches on center and lace with wire of the same diameter as the welded wire fabric. Offset splices in adjacent widths to prevent continuous splices.

G. Mechanical reinforcing steel coupling system shall be used only where shown on the Drawings. Offset splices in adjacent bars by at least 30 bar diameters. Mechanical reinforcing steel coupling system is only to be used for special splice and dowel conditions approved by the Engineer.

3.04 ACCESSORIES

A. Determine, provide and install accessories such as chairs, chair bars and the like to support the reinforcement providing the spacing and clearances indicated on the Drawings and prevent its displacement during the erection of the reinforcement and the placement of concrete.

B. Use precast concrete blocks where the reinforcing steel is to be supported over soil.

C. Use plastic protected bar supports or steel supports with plastic tips where the reinforcing steel is to be supported on forms for a concrete surface that will be exposed to weather, high humidity, or liquid (including bottom of slabs over liquid containing areas). Use stainless steel protected bar supports in walls, beams and elevated slabs. Use stainless steel supports or plastic tipped metal supports in all other locations unless otherwise noted on the Drawings or specified herein.

D. Provide #5 minimum size support bars. Do not reposition upper bars in a bar mat for use as support bars.

E. Alternate methods of supporting top steel in slabs, such as steel channels supported on the bottom steel or vertical reinforcing steel fastened to the bottom and top mats, may be used if approved by the Engineer.

3.05 INSPECTION

A. Notify the Engineer when the reinforcing is complete and ready for inspection, at least 24 hours prior to the proposed concrete placement. Do not cover reinforcing steel with concrete until the installation of the reinforcement, including the size, spacing and position of the reinforcement has been inspected by the Engineer and the Engineer's release to proceed with the concreting has been obtained. Keep forms open until the Engineer has completed inspection of the reinforcement.

END OF SECTION

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SECTION 03250

CONCRETE JOINTS AND JOINT ACCESSORIES

PART 1: GENERAL

1.01 SCOPE OF WORK

A. Furnish all labor, materials, equipment and incidentals required and install accessories for concrete joints complete as shown on the Drawings and as specified herein.

1.02 RELATED WORK

A. Watertightness test for water containing structures is included in Section 01480.

B. Concrete formwork is included in Section 03100.

C. Concrete reinforcement is included in Section 03200.

D. Cast-in-place concrete is included in Section 03300.

E. Concrete finishes are included in Section 03350.

F. Grout is included in Section 03600.

G. Modifications to existing concrete are included in Section 03740.

H. Miscellaneous metals are included in Section 05500.

I. Waterproofing, dampproofing and caulking are included in Section 07005.

1.03 SUBMITTALS

A. Submit, in accordance with Section 01300, shop drawings and product data for:

1. Plastic Waterstops: Product data including sample, catalogue cut, dimensions, technical data, storage requirements, splicing methods, conformity to CRD standards, detailed drawings and samples of factory fabrications.

2. Special Waterstops: Product data including location of use, sample, catalogue cut, technical data, storage requirements, splicing methods, installation instructions, and conformity to CRD, ASTM or FS standards, as applicable.

a. Injectable Waterstop Hose System: In addition to the requirements specified above. Submit applicator certification by manufacturer of injectable waterstop hose system. Submit manufacturer's specifications for cleaning and preparing surfaces to receive waterstop system and instructions for installation and injection. Include manufacturer product data confirming that materials are recommended for applications indicated on the Drawings and recommendations for inspection. Submit installation drawings showing layout, injection locations and details of injectable waterstop hose system.

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b. Reinjectable Waterstop Hose System: In addition to the requirements specified above: Submit applicator certification by manufacturer of reinjectable waterstop hose system. Applicator shall have a minimum of 5 years experience installing reinjectable waterstop hose systems. Submit manufacturer's specifications for cleaning and preparing surfaces to receive waterstop system and instructions for installation, injection and vacuuming of hose. Include manufacturer product data confirming that materials are recommended for applications indicated on the Drawings and recommendations for inspection. Submit installation drawings showing layout, junction box location and details of reinjectable waterstop hose system.

3. Premolded joint fillers: Product data including location of use, sample, catalogue cut, technical data, storage requirements, installation instructions, and conformity to ASTM standards.

4. Preformed expansion joint material: Product data including location of use, catalogue cut, dimensions, technical data, storage requirements, installation instructions, and conformity to ASTM standards.

5. Bond breaker: Product data including location of use, catalogue cut, technical data, storage requirements, and application instructions.

6. Expansion joint dowels: Product data on the complete assembly including dowel material, sizes and dimensions, coatings, expansion dowel caps, installation instructions and conformity to ASTM standards.

7. Sealant: Product data including location of use, catalogue cut, technical data, storage requirements, mixing and application instructions, and conformity to ASTM standards.

8. Neoprene bearing pads: Product data including location of use, sample, catalogue cut, dimensions, technical data, storage requirements, installation instructions, and conformity to AASHTO standards.

B. Certifications

1. Certify that all materials used within the joint system are compatible with each other.

2. Certify that sealant is made for use in continuous immersion in contact with wastewater.

1.04 REFERENCE STANDARDS

A. American Society for Testing and Materials (ASTM)

1. ASTM A675 - Standard Specification for Steel Bars, Carbon, Hot Wrought, Special Quality, Mechanical Properties.

2. ASTM C309 - Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete.

3. ASTM C920 - Standard Specification for Elastomeric Joint Sealants.

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4. ASTM D1752 - Standard Specification for Preformed Sponge Rubber Cork and Recycled PVC Expansion Joint Fillers for Concrete Paving and Structural Construction.

5. ASTM D2240 Standard Test Method for Rubber Property—Durometer Hardness.

B. U.S. Army Corps of Engineers (CRD).

1. CRD C572 - Specification for Polyvinylchloride Waterstops.

C. American Association of State Highway and Transportation Officials (AASHTO)

1. Standard Specifications for Highway Bridges

D. Federal Specifications (FS)

1. FS SS-S-210A - Sealing Compound for Expansion Joints.

E. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.05 QUALITY ASSURANCE

A. Provide services of a manufacturer's field representative of the sealant who has performed at least five projects of similar size and complexity within the last 5 years. The field representative shall be present at the work site prior to any mixing of components to instruct on mixing, application and inspection procedures and to inspect the finish of the prepared surfaces prior to application of the sealant.

B. The manufacturer's field representative shall make at least one additional visit to the site as the work progresses and shall report on each visit to the Contractor and the Engineer, advising as to whether the application is being performed in accordance with this Section and the manufacturer's printed instructions.

C. Injectable waterstop hose system and reinjectable waterstop hose system shall be installed by an applicator certified by the manufacturer.

1.06 DELIVERY, STORAGE AND HANDLING

A. Deliver products in original, unopened containers displaying the manufacturer's label showing manufacturer name, product identification and batch number.

B. Store products as recommended by the manufacturer.

PART 2: PRODUCTS

2.01 GENERAL

A. All materials used together in a given joint shall be compatible with one another. Coordinate selection of suppliers and products to provide compatibility. Do not use asphaltic bond breakers or asphaltic joint fillers in joints receiving sealant.

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B. All injectable waterstop hose systems, reinjectable waterstop hose systems, expansive waterstops, and adhesive waterstops shall be products specifically manufactured for the purpose for which they will be used and the products shall have been successfully used in similar applications for more than five years.

2.02 MATERIALS

A. Plastic Waterstops

1. Waterstops for expansion joints: 9-inch by 3/8-inch ribbed type waterstops with a center bulb conforming to CRD C572 and made by extruding elastomeric plastic compound with virgin polyvinylchloride as the basic resins. The compound shall contain no reprocessed materials. Minimum tensile strength of waterstop is 1750 psi. Waterstops shall incorporate an integral fastening system, or be provided with grommets or pre-punched holes between the outermost ribs at a spacing of 12 inches on center. Waterstops shall be style CR-9380 by Paul Murphy Plastics Co., Roseville, MI; style 696 by Greenstreak Plastic Products, St. Louis, MO; style RLB9-38 by Vinylex Corp., Knoxville, TN, or equal.

2. Waterstops for non-expansion joints and other locations shown on the Drawings: 6-in by 3/8-in. ribbed type waterstops conforming to CRD C572 and made by extruding elastomeric plastic compound with virgin polyvinylchloride as the basic resins. The compound shall contain no reprocessed materials. Minimum tensile strength of waterstop 1750 psi. Waterstops shall incorporate an integral fastening system, or be provided with grommets or pre-punched holes between the outermost ribs at a spacing of 12 inches on center. Waterstops shall be style FR-6380 by Paul Murphy Plastics Co., Roseville, MI; style 679 by Greenstreak Plastic Products, St. Louis, MO; style R6-38 by Vinylex Corp., Knoxville, TN, or equal.

3. Factory fabrications: provide factory fabrications for all waterstop changes of direction, transitions, and intersections (vertical ells, flat ells, vertical tees, flat tees, vertical crosses, flat crosses, and special unusual or complicated intersections including intersections of waterstops of different sizes or configurations, and intersections due to joint offsets). Factory fabrications shall be made and inspected by the waterstop manufacturer. Provide stub ends of sufficient length to leave only straight butt joints for splicing in the field.

B. Special Waterstops

1. PVC Retrofit Waterstops for non-expansion joints: "T" type waterstop conforming to CRD C572 and made by extruding elastomeric plastic compound with virgin polyvinylchloride as the basic resins. The compound shall contain no reprocessed materials. Minimum tensile strength of waterstop 1750 psi. Waterstop shall be style 609 system, complete with Type 304 stainless steel batten bars and 1/4-inch diameter stainless steel expansion bolts, by Greenstreak Plastic Products, St. Louis, MO or equal.

2. Injectable Waterstop Hose System for non-expansion joints where shown on the Drawings: The injectable waterstop hose system shall be comprised of a hose utilizing a spiral core enclosed within an exterior membrane, injectable grout/resin, anchoring clips, packers and all other accessories necessary for a complete injectable waterstop hose system. Injectable waterstop hose system shall be Injecto Tube with Hydro Active Injecto Grout manufactured by De Neef Construction Chemicals, Inc., Houston, TX, Duroject

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Injection Hose with Multigel 850 Injection Resin manufactured by BBZ USA, Inc., Southington, CT; or equal.

3. Reinjectable Waterstop Hose System for non-expansion joints where shown on the Drawings: The reinjectable waterstop hose system shall be Fuko Type I hose with Multigel 850 Injection Resin, colored vent ends, junction boxes, anchor clips, closure plugs and all other accessories necessary for a complete reinjectable waterstop hose system manufactured by BBZ USA, Inc., Southington, CT; or equal.

4. Type A Expansive Waterstops for construction joints where shown on the Drawings: A preformed bentonite/butyl rubber based system. Installation adhesives used with the expansive waterstops shall be as recommended by the waterstop manufacturer. The waterstop shall be Volclay Waterstop-RX101 as manufactured by Colloid Environmental Technologies Company, Arlington Heights, IL; ¾-in. by 1-in. Swellstop by Greenstreak Plastic Products, St. Louis, MO, Adcor ES by W.R. Grace, or equal.

5. Type B Expansive Waterstops for construction joints where shown on the Drawings: Preformed hydrophilic rubber strips. Installation adhesives used with the expansive waterstops shall be as recommended by the waterstop manufacturer. The waterstop shall be Adeka Ultraseal MC-2010MN as distributed by Mitsubishi of Houston, TX; Hydrotite CJ-1020-2K by Greenstreak Plastic Products, St. Louis, MO, Adcor ES by W.R. Grace, Cambridge, MA, or equal.

6. Preformed Adhesive Waterstops for construction joints where shown on the Drawings: A rope type preformed plastic waterstop meeting the requirements of Federal Specification SS-S-210A. The rope shall have a cross-sectional area of approximately one square inch unless otherwise specified or shown on the Drawings. The waterstop shall be Synko-Flex Waterstop SF-302 as manufactured by Henry Company, El Segundo, CA or equal. Primer for the material shall be as recommended by the waterstop manufacturer.

C Premolded Joint Filler

1. Premolded Joint Filler – Structures: Self-expanding cork pre-molded joint filler conforming to ASTM D1752, Type III. Provide 1-inch thickness unless otherwise indicated on the Drawings.

D. Bond Breaker

1. Bond Breaker Tape: Adhesive-backed glazed butyl or polyethylene tape which will adhere to the pre-molded joint filler or concrete surface. Provide tape the same width as the joint.

2. Bond breaker for concrete other than where tape is indicated on the Drawings or specified: Either bond breaker tape or a non-staining type bond prevention coating such as Crete-Lease Bond Breaker for Tilt-Up by Cresset Chemical Co.; Sure-Lift J-6 WB by Dayton Superior; Silcoseal Select by Nox-Crete, or equal.

3. Bond breaker for expansion joint dowels: Water based white pigmented curing compound conforming to ASTM C309, Type 2, Class A.

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E. Preformed Expansion Joint Material

1. A non-extrudable watertight strip material used to fill expansion joints between structures. The material shall be capable of being compressed at least 40 percent for 70 hours at 68 degrees F and subsequently recovering at least 20 percent of its original thickness in the first 1/2 hour after unloading. Preformed expansion joint material shall be Phyzite 380 by Chase Construction Products, Albany, NY or equal.

F. Expansion Joint Dowels

1. Smooth underformed steel bars conforming to ASTM A615, Grade 60. Provide dowels straight and clean, free of loose flaky rust and loose scale. Dowels may be sheared to length provided deformation from true shape caused by shearing does not exceed 0.04-in. on the diameter of the dowel and extends no more than 0.04 inch from the end. Coat bars with a bond breaker on the expansion end of the dowel. Provide expansion dowel caps on the expansion end.

2. Expansion Dowel Caps: No. 87 Dowel Caps by Heckmann Building Products, Inc.; Style K-11 Dowel Caps by the Dayton Superior Corporation; Style 3070 Expansion Tube by Meadow Steel Products, Inc., or equal.

G. Sealant

1. Provide sealant for joints in horizontal surfaces conforming to ASTM C920, Type S or M, Grade P or NS, Class 25. Provide sealant for joints in sloping and vertical surfaces conforming to ASTM C920, Type S or M, Grade NS, Class 25. Provide Use T sealant in pedestrian and vehicular traffic areas and Use NT in non-traffic areas.

2. Provide sealants made for use in continuous immersion in contact with wastewater. Provide gray colored sealants unless otherwise indicated on the Drawings, specified, or approved.

H. Neoprene Bearing Pads: 50 durometer conforming to AASHTO Standard Specifications for Highway Bridges.

PART 3: EXECUTION

3.01 INSTALLATION

A. Waterstops - General

1. Install waterstops for all joints as shown on the Drawings. Provide waterstops continuous around all corners and intersections so that a continuous seal is provided.

2. Provide a minimum number of connections or splices. Replace connections or splices that do not meet the specified requirements at no additional cost to the Owner.

3. Secure waterstops in joints before concrete is placed.

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4. Install waterstops so that half of the width will be embedded on each side of the joint. Install waterstops with a center bulb in expansion joints so that the center bulb is within the joint width. Provide waterstops completely embedded in void-free concrete.

5. Terminate waterstops 2-in. below the exposed top of walls.

6. Protect waterstops from damage in the internals between placing waterstops and subsequent placing of concrete. Replace damaged or punctured waterstops at no additional cost to the Owner.

7. Protect plastic waterstops from sunlight when they will be exposed more than 30 days between concrete placements.

8. Provide waterstops free from form release agent, bond breaker, dirt, concrete splatter, ice, mortar, paint, or any other material which could reduce or destroy bond between the waterstop and the concrete to be placed around it.

B. Plastic Waterstops

1. Only straight butt joints are allowed for field splices. Make splices on a bench. Use a power saw and guide to cut straight ends to be spliced. Heat fuse weld splices using a Teflon coated thermostatically controlled waterstop splicing iron following the manufacturer's recommendations. The finished splices shall provide a cross-section that is dense and free of porosity. Engineer may conduct destructive tests of splices by cutting along one half of the splice length and by cutting perpendicular to the splice at several locations on the remaining half of the splice length. The right of the Engineer to make such tests shall not be construed as creating any obligation to make such tests, and not exercising this right to do so shall not relieve the Contractor from meeting the requirements of these Specifications. Completed splices shall exhibit a continuous and uniform bead of excess melted material. The welded material shall not look noticeably different from the parent material. Splices shall not show misalignment of center bulbs or ribs greater than 1/16-in., lack of fusion, porosity, pinholes, cracks, charred or burnt material, bubbles, or separation of cooled splice when bent by hand. If a splice displays any of these defects, reject the splice, re-cut back at least 1-in. from rejected splice on each side, and re-weld.

2. Secure waterstops in wall joints before concrete is placed. If waterstop does not incorporate an integral fastening system, grommets or pre-punched holes, drill holes in waterstops between the outermost ribs at each edge. Center the waterstop in the joint. Tie both edges of the waterstop to reinforcing steel with tie wire as specified for tying reinforcing steel. Secure the waterstop centered on and perpendicular to the joint and to maintain this position during concrete placement.

3. Space waterstop ties to match the spacing of the adjacent reinforcing, but ties need not be spaced closer than 12-in. on center.

4. Clamp horizontal waterstops in slabs in position with the form bulkhead (unless previously set in concrete). Lift the edge of the waterstop while placing concrete below the waterstop. Manually force the waterstop against and into the placed concrete and cover with fresh concrete, to provide complete encasement of the waterstop in concrete.

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C. Special Waterstops

1. Install special waterstops at joints only where specifically shown on the Drawings. Provide waterstops continuous around all corners and intersections so that a continuous seal is provided.

2. Each piece of the waterstop shall be of maximum practicable length to provide a minimum number of connections or splices. Connections and splices shall conform to the manufacturer's recommendations and as specified herein.

3. Terminate waterstops 2-in. below the exposed top of walls. Plug bulbs in PVC retrofit waterstops with foam rubber, 1-in. deep, at all points of termination.

4. Splice PVC retrofit waterstops and secure projecting portion to reinforcing steel as specified for plastic waterstops. Clean existing concrete of all foreign material and patch as necessary to form a smooth plane surface. Adhesives, fastening devices, and fastener spacing shall conform to the manufacturer's recommendations.

5. Maximum length of injectable waterstop hose shall be 25 linear feet. Splice consecutive lengths of hose by overlapping in accordance with the manufacturer's specifications. Hold hose in place with anchor clips at the spacing specified by the manufacturer. Do not fasten the injection hoses to reinforcing steel. Patch all visible honeycombs at the concrete surface prior to injection. Begin injection process when concrete has cured not less than 28 days. Perform injection in compliance with manufacturer's specifications and ensure injection hose is properly sealed upon completion.

6. Maximum length of reinjectable waterstop hose shall be 33 linear feet. Longer lengths may be fabricated in accordance with manufacturer's recommendations. Splice consecutive lengths of hose by overlapping in accordance with the manufacturer's specifications. Hold hose in place with anchor clips at the spacing specified by the manufacturer. Do not fasten the injection hoses to reinforcing steel. Patch all visible honeycombs at the concrete surface prior to injection. Begin injection process when concrete has cured not less than 28 days. Initial injection pressure shall be between 75-150 psi, increasing pressure to 500-600 psi for 3-5 minutes as the hose fills. Once injection has been completed vacuum the hose with clean water, leaving it clear for reinjection if necessary. If leakage occurs perform reinjection in accordance with the manufacturer's specifications. Encase all hose vent ends in a plastic junction box as specified by the manufacturer. The junction box shall be accessible for any future re-injections.

7. Clean and prepare joint surfaces, install primers or adhesives, and install Type A expansive, Type B expansive, or [preformed adhesive] waterstops on dry surfaces in accordance with the manufacturer's instructions including concrete cure, temperature conditions, and splices. Use mechanical fasteners to secure Type A expansive, or Type B expansive waterstops to previously placed vertical and overhead concrete surfaces, and other locations, as recommended by the manufacturer. Protect installed waterstops from moisture and keep dry until subsequent placement of concrete.

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D. Construction Joints

1. Make construction joints only at locations shown on the Drawings or as approved by the Engineer. Any additional or relocation of construction joints proposed by the Contractor must be submitted to the Engineer for written approval. Do not eliminate construction joints.

2. Locate additional or relocated joints where they least impair strength of the member. In general, locate joints within the middle third of spans of slabs, beams and girders. However, if a beam intersects a girder at the joint, offset the joint a distance equal to twice the width of the member being connected. Locate joints in walls and columns at the underside of floors, slabs, beams or girders and at tops of footings or floor slabs. Do not locate joints between beams, girders, column capitals, or drop panels and the slabs above them. Do not locate joints between brackets or haunches and walls or columns supporting them.

3. Unless indicated otherwise, provide joints perpendicular to main reinforcement. Continue reinforcing steel through the joint as indicated on the Drawings. Provide inclined dowels at construction joints in beams, as detailed on the Drawings.

4. Provide waterstops in wall and slab construction joints in liquid retaining structures and at other locations shown on the Drawings.

5. At all construction joints and at concrete joints indicated on the Drawings to be "roughened", uniformly roughen the surface of the concrete to a full amplitude (distance between high and low points and side to side) of 1/4 inch with chipping tools to expose a fresh face. Thoroughly clean joint surfaces of loose or weakened materials by water blasting or sandblasting and prepare for bonding. At least two hours before and again shortly before the new concrete is deposited, saturate the joints with water. After glistening water disappears, coat joints with neat cement slurry mixed to the consistency of very heavy paste. The surfaces shall receive a coating at least 1/8-inch-thick, scrubbed in by means of stiff bristle brushes. Deposit new concrete before the neat cement dries.

6. Do not use keyways in construction joints unless specifically shown on the Drawings or approved by the Engineer.

E. Expansion Joints

1. Make expansion joints at locations indicated on the Drawings. Do not eliminate or relocate expansion joints.

2. Provide expansion joints 1-in. in thickness unless otherwise indicated on the Drawings.

3. Provide center bulb type waterstops, sealant grooves, and sealants in wall and slab expansion joints in liquid retaining structures and at other locations shown on the Drawings.

4. Do not extend through expansion joints, reinforcement or other embedded metal items that are continuously bonded to concrete on each side of joint.

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5. Where indicated on the Drawings install smooth dowels at right angles to expansion joints. Align dowels parallel with finished surface. Rigidly hold in place and support during concrete placement. Unless otherwise indicated on the Drawings apply a bond breaker to one end of all dowels through expansion joints. Mask waterstops to prevent bond breaker from running or dripping on to them. Remove masking prior to concrete placement. Provide expansion dowel caps on the ends of expansion joint dowels to which bond breaker has been applied.

6. Place joint filler over the face of the joint, allowing for sealant grooves as indicated. Butt joint filler tight against waterstop, if present. Tape all joint filler splices to prevent intrusion of mortar. Position pre-molded joint filler material parallel to finished surfaces. Secure the joint filler against displacement during concrete placement and consolidation. Seal expansion joints as indicated on the Drawings.

F. Partial Contraction Joints

1. Make partial contraction joints at locations shown on the Drawings. Do not eliminate or relocate partial contraction joints.

2. Provide waterstops, sealant grooves, and sealants in wall and slab partial contraction joints in liquid retaining structures and at other locations shown on the Drawings.

3. Extend every other bar of reinforcing steel through partial contraction joints or as indicated on the Drawings. Coat the concrete surface with a bond breaker prior to placing new concrete against it as shown on the Drawings. Do not coat reinforcement or waterstops with bond breaker. Mask waterstops and reinforcing passing through the joint to prevent bond breaker form running or dripping on to them. Remove masking prior to concrete placement.

G. Sealant

1. Install sealants in clean dry recesses free of frost, oil, grease, form release agent, loose material, laitance, dirt, dust and other materials which will impair bond at the locations shown on the Drawings. Apply sealant conforming to the manufacturer's recommendations including concrete cure, temperature, moisture, mixing, primer, primer cure time, joint and recess preparation, tooling, and curing. Apply masking tape to each side of the joint prior to the installation of the sealant and remove afterwards along with any spillage to leave a sealant installation with neat straight edges.

H. Preformed Expansion Joint Material

1. Install preformed expansion joint material in conformance with the manufacturer's recommendations; including surface preparation, adhesive installation, heat welding and set time.

END OF SECTION

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SECTION 03300

CAST-IN-PLACE CONCRETE

PART 1: GENERAL

1.01 SCOPE OF WORK

A. Furnish all labor, materials, equipment, and incidentals required and install cast-in-place concrete complete as shown on the Drawings and as specified herein.

B. Furnish, as required to establish concrete mixes, all sampling and laboratory testing of products and materials performed by an independent testing laboratory engaged by and at the expense of the Contractor. Field sampling, testing, inspection and related laboratory tests will be provided by the Owner.

1.02 RELATED WORK

A. Watertightness test for water containing structures is included in Section 01480.

B. Concrete formwork is included in Section 03100.

C. Concrete reinforcement is included in Section 03200.

D. Concrete joints and joint accessories are included in Section 03250.

E. Concrete finishes are included in Section 03350.

F. Grout is included in Section 03600.

G. Modifications to existing concrete are included in Section 03740.

H. Concrete electrical raceway encasement is included in Section 03800.

I. Miscellaneous metals are included in Section 05500.

J. Metal stairs are included in Section 05510.

K. Waterproofing, dampproofing, and caulking are included in Section 07005.

1.03 SUBMITTALS

A. Submit, in accordance with Section 01300, product data for:

1. Sources of cement, fly ash, aggregates, and batched concrete.

2. Air-entraining admixture. Product data including catalogue cut, technical data, storage requirements, product life, recommended dosage, temperature considerations and conformity to ASTM standards.

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3. Water reducing admixture. Product data including catalogue cut, technical data, storage requirements, product life, recommended dosage, temperature considerations and conformity to ASTM standards.

4. Sheet curing material. Product data including catalogue cut, technical data and conformity to ASTM standard.

5. Material Safety Data Sheets (MSDS) for all concrete components and admixtures.

6. High-range water reducing admixture (plasticizer). Product data including catalogue cut, technical data, storage requirements, product life, recommended dosage, temperature considerations, retarding effect, slump range and conformity to ASTM standards. Identify proposed locations of use.

7. Liquid membrane forming curing compound. Product data including catalogue cut, technical data, storage requirements, product life, application rate and conformity to ASTM standards. Identify proposed locations of use.

B. Samples

1. Fine and coarse aggregates if requested for examination by the Engineer.

C. Test Reports

1. Aggregates: Conformance to ASTM standards, including sieve analysis, mechanical properties, deleterious substance content, and mortar bar expansion test results.

2. Cement and fly ash: Conformance to ASTM standards, including chemical analysis and physical tests.

3. Concrete mixes: For each formulation of concrete proposed for use, submit constituent quantities per cubic yard, water cementitious ratio, air content, concrete slump, type and manufacturer of cement and type and manufacturer of fly ash. Provide either Paragraph a. or b., below, for each mix proposed.

   a. Standard deviation data for each proposed concrete mix based on statistical records.

   b. Provide the following for each strength data point used in the calculation of the standard deviation for determination of the minimum required average strength:

      1) Date of sampling and name of testing laboratory.

      2) Name of concrete batch plant.

      3) Water cementitious ratio.

      4) Slump of batch.

      5) Air content of batch.

      6) Compressive strengths of all cylinders tested at that age in that batch.

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7) If available, temperature and unit weight of batch.

c. Provide data from projects not more strictly controlled than outlined in these Specifications. Provide summary sheet showing all pertinent data and the computation of the standard deviation.

d. Water cementitious ratio curve for concrete mixes based on laboratory tests. Provide average cylinder strength test results at 7, 14, and 28 days for laboratory concrete mix designs.

D. Certifications

1. Certify that admixtures used in the same concrete mix are compatible with each other and the aggregates.

2. Certify that the Contractor is not associated with the independent testing laboratory proposed for use by the Contractor nor does the Contractor or officers of the Contractor's organization have a beneficial interest in the laboratory.

3. Certify that cement is produced by a manufacturer that does not use hazardous waste derived fuel as an energy source for its kilns.

4. Certificate of conformance for concrete production facilities from the NRMCA.

E. Qualifications

1. Independent Testing Laboratory

a. Name and address

b. Names and positions of principal officers and the name, position, and qualifications of the responsible registered professional engineer in charge.

c. Listing of technical services to be provided. Indicate external technical services to be provided by other organizations.

d. Names and qualifications of the supervising laboratory technicians.

e. Statement of conformance provided by evaluation authority defined in ASTM C1077. Provide report prepared by evaluation authority when requested by the Engineer.

f. Submit as required above for other organizations that will provide external technical services.

1.04 REFERENCE STANDARDS

A. American Society for Testing and Materials (ASTM)

1. ASTM C31 - Standard Practice for Making and Curing Concrete Test Specimens in the Field.

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2. ASTM C33 - Standard Specification for Concrete Aggregates.
3. ASTM C39 - Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.
4. ASTM C42 - Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete.
5. ASTM C94 - Standard Specification for Ready-Mixed Concrete.
6. ASTM C138 – Standard Test Method for Density (Unit Weight), Yield, and Air Content (Gravimetric) of Concrete.
7. ASTM C143 - Standard Test Method for Slump of Hydraulic-Cement Concrete.
8. ASTM C150 - Standard Specification for Portland Cement.
9. ASTM C156 - Standard Test Method for Water Retention by Liquid Membrane-Forming Curing Compound for Concrete.
10. ASTM C171 - Standard Specification for Sheet Materials for Curing Concrete.
11. ASTM C173 - Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method.
12. ASTM C192 – Standard Practice for Making and Curing Concrete Test Specimens in the Laboratory.
13. ASTM C231 - Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method.
14. ASTM C260 - Standard Specification for Air-Entraining Admixtures for Concrete.
15. ASTM C309 - Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete.
16. ASTM C311 - Standard Test Methods for Sampling and Testing Fly Ash or Natural Pozzolans for use in Portland Cement Concrete.
17. ASTM C494 - Standard Specification for Chemical Admixtures for Concrete.
18. ASTM C618 - Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete.
19. ASTM C1017 - Standard Specification for Chemical Admixtures for use in Producing Flowing Concrete.
20. ASTM C1077 - Standard Practice for Laboratories Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Laboratory Evaluation.

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21. ASTM C1260 - Standard Test Method for Potential Alkali Reactivity of Aggregates (Mortar-Bar Method).

22. ASTM E329 - Standard Specification for Agencies Engaged in Construction Inspection and/or Testing.

B. American Concrete Institute (ACI).

1. ACI 211.1 - Standard Practice for Selecting Proportions for Normal, Heavyweight and Mass Concrete.

2. ACI 232.2R - Use of Fly Ash in Concrete.

3. ACI 304R - Guide for Measuring, Mixing, Transporting and Placing Concrete.

4. ACI 304.2R - Placing Concrete by Pumping Methods.

5. ACI 305R - Hot Weather Concreting.

6. ACI 306R - Cold Weather Concreting.

7. ACI 350 - Code Requirements for Environmental Engineering Concrete Structures and Commentary.

C. National Ready Mixed Concrete Association (NRMCA)

1. Quality Control Manual, Section 3 - Certification of Ready Mixed Concrete Production Facilities.

D. Truck Mixer Manufacturers Bureau (TMMB)

1. TMMB 100 - Truck Mixer, Agitator and Front Discharge Concrete Carrier Standards.

E. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.05 QUALITY ASSURANCE

A. Comply with ACI 350 and other stated specifications, codes and standards. Apply the most stringent requirements of other stated specifications, codes, standards, and this Section when conflicts exist.

B. Independent testing laboratory shall meet the requirements of ASTM E329 and ASTM C1077 and be acceptable to the Engineer. Laboratories affiliated with the Contractor or in which the Contractor or officers of the Contractor's organization have a beneficial interest are not acceptable.

C. Use only one source of cement and aggregates for the project. Provide concrete uniform in color and appearance.

D. At least ten working days before the first concrete placement hold a preconstruction meeting to review the requirements for concrete placement, waterstop placement, jointing, concrete curing, hot weather concreting, cold weather concreting and finishing. Review, with the attendance of the plasticizer manufacturer, the properties and techniques of batching and placing concrete containing high-range water-reducing admixture. Notify all parties involved, including the Engineer, of the meeting at least ten working days prior to its scheduled date. Prepare an agenda for the meeting. Take meeting minutes and distribute to all attendees.

E. If, during the progress of the work, it is impossible to secure concrete of the specified workability and strength with the materials being furnished, the Engineer may order such changes in proportions or materials, or both, as may be necessary to secure the specified properties. Make all changes so ordered at no additional cost to the Owner.

F. If, during the progress of the work, the materials from the sources originally accepted change in characteristics, make, at no additional cost to the Owner, new acceptance tests of materials and establish new concrete mixes with the assistance of an independent testing laboratory.

G. All field testing and inspection services and related laboratory tests required will be provided by the Owner. The cost of such work will be paid for by the Owner. Methods of testing will comply with the latest applicable ASTM methods. The following items will be tested by the Owner to verify conformity with this Section.

1. Concrete placements - compressive strength (cylinders), compressive strength (cores), temperature, slump, and air content.

2. Other materials that may require field testing.

H. Samples of constituents and of concrete as placed will be subjected to laboratory tests by the Owner. All materials incorporated in the work shall conform to accepted samples.

1.06 DELIVERY, STORAGE AND HANDLING

A. Cement: Store in weathertight buildings, bins or silos to provide protection from dampness and contamination and to prevent warehouse set.

B. Aggregate: Arrange and use stockpiles to prevent segregation or contamination with other materials or with other sizes of like aggregates. Build stockpiles in successive horizontal layers not exceeding three feet in thickness. Complete each layer before the next is started. Do not use frozen or partially frozen aggregate.

C. Sand: Arrange and use stockpiles to prevent contamination. Allow sand to drain to a uniform moisture content before using. Do not use frozen or partially frozen sand.

D. Admixtures: Store in closed containers to prevent contamination, evaporation or damage. Provide agitating equipment to uniformly disperse ingredients in admixture solutions which tend to separate. Protect liquid admixtures from freezing and other temperature changes which could adversely affect their characteristics.

E. Fly Ash: Store in weathertight buildings, bins or silos to provide protection from dampness and contamination.

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F. Sheet Curing Materials: Store in weathertight buildings or off the ground and under cover.

G. Liquid Membrane Forming Curing Compounds: Store in closed containers.

PART 2: PRODUCTS

2.01 GENERAL

A. The use of manufacturer's name and model or catalog number is for the purpose of establishing the standard of quality and general configuration desired.

B. Like items of materials shall be the end products of one manufacturer in order to provide standardization for appearance, maintenance and manufacturer's service.

2.02 MATERIALS

A. Materials shall comply with this Section and any applicable State or local requirements.

B. Cement: Domestic Portland cement conforming to ASTM C150. Cement shall be low alkali cement. Do not use air entraining cements. Cement brand must be approved by the Engineer and one brand shall be used throughout the work. Provide the following type(s) of cement:

1. All Classes of Concrete - Type I with the addition of fly ash resulting in $C_3A$ being below 8 percent of total cementitious content, or Type II.

C. Aggregates:

1. Fine Aggregate: Washed inert natural sand conforming to ASTM C33.

2. Coarse Aggregate: Well-graded crushed stone or washed gravel conforming to ASTM C33. Grading requirements as listed in ASTM C33, Table 2 for the specified coarse aggregate size number listed in Table 1 herein. Limits of deleterious substances and physical property requirements as listed in ASTM C33, Table 3 for severe weathering regions. Do not use coarse aggregates known to be deleteriously reactive with alkalis in cement.

3. The fine and coarse aggregates used shall not cause expansion of mortar bars greater than 0.1 percent in 16 days when tested in accordance with ASTM C1260 and using the cement proposed for the project. If aggregates proposed for use do not meet this requirement, then satisfy either a. or b. below.

a. Total equivalent alkali content of the cement used shall not exceed 0.60 percent as provided in the Optional Chemical Requirements of ASTM C150.

b. The fine and coarse aggregates used shall not cause expansion of mortar bars greater than 0.1 percent in 16 days when tested in accordance with ASTM C1260 and using the cement and fly ash proposed for the project. The proportions of the cement-fly ash mix shall be the same as those proposed for the project.

D. Water: Potable water free of oil, acid, alkali, salts, chlorides (except those attributable to drinking water), organic matter, or other deleterious substances.

E. Admixtures: Use admixtures free of chlorides and alkalis (except for those attributable to drinking water). The admixtures shall be from the same manufacturer when it is required to use more than one admixture in the same concrete mix. Use admixtures compatible with the concrete mix including other admixtures [and made for use in concrete in contact with potable water after 30 days of concrete curing].

1. Air Entraining Admixture: Conforming to ASTM C260. Proportion and mix in accordance with manufacturer's recommendations.

2. Water Reducing Admixture: Conforming to ASTM C494, Type A. Proportion and mix in accordance with manufacturer's recommendations.

3. High-Range Water-Reducing Admixtures (Plasticizer): Conforming to ASTM C494, Type F or ASTM C1017, Type I resulting in non-segregating plasticized concrete with little bleeding and with the physical properties of low water/cementitious ratio concrete. The treated concrete shall be capable of maintaining its plastic state in excess of 2 hours. Proportion and mix in accordance with manufacturer's recommendations.

4. Do not use admixtures causing retarded or accelerated setting of concrete without written approval from the Engineer. Use retarding or accelerating water reducing admixtures when so approved.

F. Fly Ash: Class F fly ash complying with ASTM C618, including the requirements of Table 1 but with the Loss of Ignition (LOI) limited to 3 percent maximum and the optional physical requirements of Table 3. Test in compliance with ASTM C311 with a minimum of one sample weighing four pounds taken from each 200 tons of fly ash supplied for the project.

G. Sheet Curing Materials: Waterproof paper, polyethylene film or white burlap-polyethylene sheeting, all conforming to ASTM C171.

H. Liquid Membrane-Forming Curing Compound. Compound conforming to ASTM C309, Type 1-D (clear or translucent with fugitive dye) and containing no wax, paraffin, or oil. Curing compounds shall be non-yellowing and have a unit moisture loss no greater than 0.039 gm/cm$^2$ at 72 hours as measured by ASTM C156. Curing compound shall comply with Federal, State and local VOC limits.

## 2.03 MIXES

A. An independent testing laboratory engaged by and at the expense of the Contractor shall establish concrete mixes and perform all sampling and laboratory testing of products and materials.

B. Select proportions of ingredients to meet the design strength and materials limits specified in Table 1 and to produce placeable, durable concrete conforming to these Specifications. Proportion ingredients to produce a homogenous mixture which will readily work into corners and angles of forms and around reinforcement without permitting materials to segregate or allowing free water to collect on the surface.

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C. Base concrete mixes on standard deviation data of prior mixes with essentially the same proportions of the same constituents or, if not available, develop concrete mixes by laboratory tests using the materials proposed for the work.

1. For concrete mixes based on standard deviation data of prior mixes, submit standard deviation data of prior mixes with essentially the same proportions of the same constituents in accordance with ACI 350 and based on the modification factors for standard deviation tests contained in ACI 350.

2. For concrete mixes developed by laboratory testing, base cementitious content of the concrete on curves showing the relation between water cementitious ratio and 7, 14 and 28 day compressive strengths of concrete made using the proposed materials. Determine curves by four or more points, each representing an average value of at least three test specimens and one water-cementitious ratio at each age. Provide curves with a range of values sufficient to yield the desired data, including the compressive strengths specified, without extrapolation. The cementitious content of the concrete mixes to be used, as determined from the curve, shall correspond to the required average compressive strength in Table 5.3.2.2 of ACI 318. The resulting mix shall not conflict with the limiting values for maximum water cementitious ratio and net minimum cementitious content specified in Table 1.

D. Test the fly ash and concrete mixture to provide test data confirming that the fly ash in combination with the cement to be used meets all strength requirements and is compatible with the other concrete additives.

E. Test aggregates for potential alkali reactivity in accordance with ASTM C1260. If initial testing indicates aggregates are not potentially reactive repeat test at 3 month intervals.

F. Compression Tests: Provide testing of the proposed concrete mixes to demonstrate compliance with the compression strength requirements in conformity with the provisions of ACI 318.

G. Entrained air, as measured by ASTM C231, shall be as shown in Table 1.

1. If the air entraining agent proposed for use in the mix requires testing methods other than ASTM C231 to accurately determine air content, make special note of this requirement in the admixture submittal specified under Paragraph 1.03.

H. Slump of the concrete as measured by ASTM C143, shall be as shown in Table 1. If a high-range water-reducing admixture (plasticizer) is used, the slump indicated shall be that measured before plasticizer is added. Plasticized concrete shall have a slump ranging from 7 to 10 inches.

I. Proportion admixtures according to the manufacturer's recommendations. Two or more admixtures specified may be used in the same mix provided that the admixtures in combination retain full efficiency and have no deleterious effect on the concrete or on the properties of the other admixture(s).

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TABLE 1

| Class | Design Strength 1 | Cement 2 | Fine Aggregate 3 | Coarse Aggregate 3 | Cementitious Content 4 |
|---|---|---|---|---|---|
| A | 2500 | Type II | Sand | 57 (9) | 440 |
| B | 3000 | Type II | Sand | 57 | 480 |
| E1 | 4500 | Type II | Sand | 467 | 560 |
| E2 | 4500 | Type II | Sand | 57 | 580 |
| E3 | 4500 | Type II | Sand | 67 | 610 |

| Class | W/C Ratio 5 | Fly Ash 6 | AE Range 7 | WR 8 | HRWR 10 | Slump Range Inches |
|---|---|---|---|---|---|---|
| A | 0.62 max. | Yes | 3.5 to 5 | Yes | No | 1-4 |
| B | 0.54 max. | Yes | 3.5 to 5 | Yes | No | 1-3 |
| E1 | 0.42 max. | Yes | 3.5 to 5 | Yes | (11) | 3-5(12) |
| E2 | 0.42 max. | Yes | 3.5 to 5 | Yes | (11) | 3-5(12) |
| E3 | 0.42 max. | Yes | 3.5 to 5 | Yes | (11) | 3-5(12) |

NOTES:
1. Minimum compressive strength in psi at 28 days
2. ASTM designation in ASTM C150
3. Size Number in ASTM C33
4. Minimum cementitious content in lbs per cubic yard (where fly ash is used cementitious content is defined as cement content plus fly ash content)
5. W/C is Maximum Water Cementitious ratio by weight
6. Fly ash content in the range of 20-25 percent of the total cement content plus fly ash content, by weight
7. AE is percent air entrainment
8. WR is water reducing admixture
9. Except as specified in Section 03800 for concrete electrical raceway encasement
10. HRWR is high-range water-reducing admixture
11. At Contractor's option, HRWR may be used in the mix
12. Maximum slump with HRWR may be increased to 7 inches to 9.5 inches

## PART 3 EXECUTION

### 3.01 MEASURING MATERIALS

A. Provide concrete composed of Portland cement, fly ash, fine aggregate, coarse aggregate, water and admixtures as specified and produced by a plant complying with ACI 350 and ASTM C94. Batch all constituents, including admixtures, at the plant. High-range water reducing admixtures may be added in the field.

B. Measure materials for batching concrete by weighing in conformity with and within the tolerances given in ASTM C94 except as otherwise specified. Use scales last certified by the local Sealer of Weights and Measures within one year of use.

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C. Weigh cement and fly ash in individual weigh batchers that are separate and distinct from the weigh batchers used for other materials. When cement and fly ash are weighed in a cumulative weigh batcher, the cement shall be weighed first.

D. Measure the amount of free water in fine aggregates within 0.5 percent with a moisture meter. Compensate for varying moisture contents of fine aggregates. Record the number of gallons of water as batched on printed batch tickets.

E. Dispense admixtures either manually using calibrated containers or measuring tanks, or by means of an automatic dispenser approved by the manufacturer of the specific admixture.

1. Charge air-entraining and chemical admixtures into the mixer as a solution using an automatic dispenser or similar metering device.

2. Inject multiple admixtures separately during the batching sequence.

3.02 MIXING AND TRANSPORTING

A. Provide ready-mixed concrete produced by equipment complying with ACI 350 and ASTM C94 and produced by a plant certified by the NRMCA. Do not hand mix. All truck mixers shall carry a rating plate conforming to TMMB 100. Clean each transit mix truck drum and reverse drum rotation before the truck proceeds under the batching plant. Equip each transit-mix truck with a continuous, nonreversible, revolution counter showing the number of revolutions at mixing speeds.

B. Transport ready-mix concrete to the site in watertight agitator or mixer trucks loaded not in excess of their rated capacities as stated on the name plate.

C. Keep the water tank valve on each transit truck locked at all times. Any addition of water must be directed by the Engineer. Incorporate water directed to be added by additional mixing of at least 50 revolutions at mixing speed after the addition of all water. Meter all added water and show the amount of water added on each delivery ticket.

D. Comply with ACI 318 and ASTM C94 for all central plant and rolling stock equipment and methods.

E. Select equipment of size and design to provide continuous flow of concrete at the delivery end. Use metal or metal lined non-aluminum discharge chutes with slopes not exceeding one vertical to two horizontal and not less than one vertical to three horizontal. Chutes more than 20-ft long and chutes not meeting slope requirements may be used if concrete is discharged into a hopper before distribution.

F. Do not re-temper (mix with or without additional cement, aggregate, or water) concrete or mortar which has partially hardened.

G. Handle concrete from mixer to placement providing concrete of specified quality in the placement area and not exceeding the maximum time interval specified in Paragraph 3.02.I.4. Dispatch trucks from the batching plant so they arrive at the work site just before the concrete is required to avoid excessive mixing of concrete while waiting or delays in placing successive layers of concrete in the forms. Remix for a minimum of 5 minutes prior to discharge or testing.

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H. Furnish a delivery ticket for ready mixed concrete to the Engineer as each truck arrives. Provide a printed record of the weight of cement and each aggregate as batched individually on each ticket. Use the type of indicator that returns for zero punch or returns to zero after a batch is discharged. Indicate for each batch the weight of fine and coarse aggregate, cement, fly ash, and water, moisture content of fine and coarse aggregate at time of batching, and types, brand and quantity of each admixture, the quantity of concrete delivered, the time any water is added and the amount, and the numerical sequence of the delivery. Show the time of day batched and time of discharge from the truck. Indicate the number of revolutions of transit mix truck.

I. Temperature and Mixing Time Control

1. In cold weather (see Paragraph 3.07D) maintain the as-mixed temperature of the concrete and concrete temperatures at the time of placement in the forms as indicated in Table 3.

2. If water or aggregate has been heated, combine water with aggregate in the mixer before cement is added. Do not add cement to mixtures of water and aggregate when the temperature of the mixture is greater than 90 degrees F.

3. In hot weather (see Paragraph 3.07E), cool ingredients before mixing to maintain temperature of the concrete below the maximum placing temperature of 90 degrees F. Well-crushed ice may be substituted for all or part of the mixing water.

4. The maximum time interval between the addition of mixing water and/or cement to the batch and the final placing of concrete in the forms shall not exceed the following:

TABLE 2

| AIR OR CONCRETE TEMPERATURE (WHICHEVER IS HIGHER) | MAXIMUM TIME |
|---|---|
| (27 Degree C) 80 Degree F to 90 Degree F (32 Degree C) | 45 minutes |
| (21 Degree C) 70 Degree F to 79 Degree F (26 Degree C) | 60 minutes |
| (5 Degree C) 40 Degree F to 69 Degree F (20 Degree C) | 90 minutes |

If an approved high-range water-reducing admixture (plasticizer) is used to produce plasticized concrete, the maximum time interval shall not exceed 90 minutes.

3.03 INSPECTION AND COORDINATION

A. Batching, mixing, transporting, placing and curing of concrete shall be subject to the inspection of the Engineer at all times. Advise the Engineer of readiness to proceed at least six working hours prior to each concrete placement. The Engineer will inspect the preparations for concreting including the preparation of previously placed concrete, the reinforcing and the alignment, cleanliness and tightness of formwork. Do not place concrete without the inspection and acceptance of the Engineer.

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3.04 EMBEDDED ITEMS

A. Secure to forms as required or set for embedment as required, all miscellaneous metal items, sleeves, reglets, anchor bolts, anchors, inserts and other items furnished under other Sections and required to be embedded into concrete. Set and secure such items in the locations and alignments needed so they are not displaced by concrete placement.

B. Clean embedded items free of rust, mud, dirt, grease, oil, ice, or other contaminants which would reduce or prevent bonding with concrete.

C. Coat or isolate all aluminum embedments to prevent aluminum-concrete reaction or electrolytic action between aluminum and steel.

D. Do not embed piping in concrete unless shown on the Drawings.

E. Do not embed electrical conduits in concrete unless shown on the Drawings.

F. Pipes and conduits embedded within a slab or wall (other than those merely passing through) shall satisfy the following, unless otherwise shown on the Drawings or approved:

1. Maximum outside dimension of pipe or conduit shall not be greater than one third the overall thickness of the slab or wall.

2. Spacing of pipes or conduits shall be greater than or equal to three diameters or widths on center.

3. Fabricate piping and conduit such that the cutting, bending, or relocation of reinforcing steel is not required.

G. Close open ends of piping, conduits, and sleeves embedded in concrete with caps or plugs prior to placing concrete.

H. Ensure all specified tests and inspections on embedded piping are completed and satisfactory before starting concrete placement. Ensure all mechanical or electrical tests and inspections are completed and satisfactory prior to starting concrete placement. Do not place concrete until unsatisfactory items and conditions have been corrected.

I. Position embedded anchor bolts using templates.

J. Check location, alignment, and support of anchor bolts, piping, electrical conduits, and other items which will be fully or partially embedded in concrete before depositing concrete. Correct mislocated and misaligned items and secure items which have become loose before depositing concrete.

K. Correct all embedded items not installed in the location or alignment needed or displaced by concrete placement at no additional cost to the Owner.

3.05 CONCRETE APPEARANCE

A. Remix concrete showing either poor cohesion or poor coating of the coarse aggregate with paste. Reject remixed concrete showing either poor cohesion or poor coating of the coarse

aggregate with paste. Make, at no additional cost to the Owner, changes in the concrete mix design for future deliveries only by adjusting one or more of the following if the slump is within the allowable limit, but excessive bleeding, poor workability, or poor finishability are observed:

1. The gradation of aggregate.

2. The proportion of fine and coarse aggregate.

3. The percentage of entrained air, within the allowable limits.

B. Provide concrete having a homogeneous structure which, when hardened, will have the specified strength, durability and appearance. Provide mixtures and workmanship such that concrete surfaces, when exposed, will require no finishing except as specified in Section 03350.

## 3.06 PLACING AND COMPACTING

A. Placing

1. Verify that all formwork completely encloses concrete to be placed and is securely braced prior to concrete placement. Remove ice, standing water, dirt, debris, and other foreign materials from forms and exposed joint surfaces. Confirm that reinforcement and other embedded items are securely in place. Have a worker at the location of the placement who can check that reinforcement and embedded items remain in designated locations and alignments while concrete is being placed. Sprinkle semi-porous subgrades or forms to eliminate suction of water from the mix. Do not place concrete on frozen subgrade, snow, or ice.

2. Deposit concrete as near its final position as possible to prevent segregation due to re-handling or flowing. Place concrete continuously at a rate that allows the concrete previously placed to be integrated with fresh plastic concrete. Do not deposit concrete which has partially hardened or has been contaminated by foreign materials or on concrete which has hardened sufficiently to cause formation of seams or planes of weakness within the section. If the section cannot be placed continuously, place construction joints as specified or as approved.

3. Pumping of concrete will be permitted. Use a mix design and aggregate sizes chosen for pumping and submit for approval. Do not use pipelines made of aluminum or aluminum alloy. When concrete is pumped, slump will be determined at point of truck discharge and air content will be determined at point of placement.

4. Remove temporary spreaders from forms when the spreader is no longer needed. Temporary spreaders may remain embedded in concrete only when made of galvanized steel or concrete and if prior approval has been obtained.

5. Do not place concrete for supported elements until concrete previously placed in the supporting element has attained design strength.

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6. Where surface mortar is to form the base of a finish, especially surfaces designated to be painted, work coarse aggregate back from forms to bring the full surface of the mortar against the form. Prevent the formation of surface voids.

7. Slabs

   a. After bulkheads, screeds and jointing materials have been positioned, place concrete continuously between joints beginning at a bulkhead, edgeform, or corner. Place each batch into the edge of the previously placed concrete to avoid stone pockets and segregation.

   b. Avoid delays in placement. If there is a delay in placement, spade and consolidate the concrete placed after the delay at the edge of the previously placed concrete to avoid cold joints. Bring concrete to correct level and strike off with a straightedge. Use bullfloats or darbies to smooth the surface, leaving it free of humps or hollows.

   c. Where slabs are to be placed integrally with the walls below them, place the walls and compact as specified. Allow one hour to pass between placement of the wall and the overlying slab to permit consolidation of the wall concrete. Keep the top surface of the wall moist to prevent cold joints.

8. Formed Concrete

   a. Place concrete in forms using tremie tubes taking care to prevent segregation. Maintain bottom of tremie tubes in contact with the concrete already placed. Do not permit concrete to drop freely more than 4 ft. Place concrete for walls in 12-inch to 24-inch lifts, keeping the surface horizontal. If a high-range water-reducing admixture is used do not permit concrete to drop freely more than 15 ft; maximum lift thickness not to exceed 7 ft.

9. Bollards

   a. Conform to requirements specified above for formed concrete and completely fill pipe with concrete as indicated.

10. Underwater Concreting

    a. Use the tremie system conforming to the recommendations of ACI 304R. Tremie pipes shall be in the range of 8 to 12 inches in diameter and be spaced at not more than 16 ft on centers nor more than 8 ft from an end form. Where concrete is being placed around a pipe, there shall be at least one tremie pipe on each side of each pipe. Where the tremie system is not practical, direct pumped concrete for underwater placement may be used subject to approval by the Engineer.

11. Do not place concrete underwater unless approved in writing by the Engineer.

B. Compacting

1. Consolidate concrete by vibration and puddling, spading, rodding or forking so that concrete is completely worked around reinforcement, embedded items and openings and into corners of forms. Continuously perform puddling, spading, rodding and forking

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along with vibration of the placement to eliminate air or stone pockets which may cause honeycombing, pitting or planes of weakness.

2. Compact all concrete with mechanical vibrators. Do not order concrete until vibrators (including standby units in working order) are on the job.

3. Use mechanical vibrators having a minimum frequency of 8000 vibrations per minute. Insert vibrators and withdraw at points from 18 inches to 30 inches apart. Vibrate sufficiently at each insertion to consolidate concrete, generally from 5 to 15 seconds. Do not over vibrate so as to segregate. Keep standby vibrators on the site during concrete placing operations.

4. Concrete Slabs: Vibration for concrete slabs less than 8-inch-thick shall be by vibrating screeds. Vibration for concrete slabs 8-inch and thicker shall be by internal vibrators and (optionally) with vibrating screeds. Place vibrators into concrete vertically. Do not lay vibrators horizontally or lay over.

5. Walls and Columns: Use internal vibrators (rather than form vibrators) unless otherwise approved by the Engineer. In general, for each vibrator needed to melt down (level) the batch at the point of discharge, one or more additional vibrators must be used to densify, homogenize and perfect the surface. Insert vibrators vertically at regular intervals, through the fresh concrete and slightly into the previous lift, if any.

6. Amount of Vibration: Use vibrators to consolidate properly placed concrete. Do not use vibrators to move or transport concrete in the forms. Continue vibration until:

   a. Frequency of vibrator returns to normal.

   b. Surface appears liquefied, flattened and glistening.

   c. Trapped air ceases to rise.

   d. Coarse aggregate has blended into surface, but has not disappeared.

## 3.07 CURING AND PROTECTION

A. Protect all concrete work against injury from the elements and defacements of any nature during construction operations.

B. Curing Methods

1. Curing Methods for Concrete Surfaces: Cure concrete to retain moisture and maintain a temperature of at least 50 Degrees F at the concrete surface for a minimum of seven days after placement. Use the following curing methods as specified:

   a. Water Curing: Keep entire concrete surface wet by ponding, continuous sprinkling or covered with saturated burlap. Begin water curing as soon as concrete attains an initial set and maintain water curing 24 hours a day. Do not permit the surface of the concrete to dry out at any time during the curing period. Temperature of curing water shall be within 20 Degrees F of the concrete temperature.

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b. Sheet Material Curing: Cover entire surface with sheet material. Anchor sheeting to prevent wind and air from lifting the sheeting or entrapping air under the sheet. Place and secure sheet as soon as initial concrete set occurs.

c. Liquid Membrane Curing: Apply over the entire concrete surface except as follows. Curing compound shall NOT be placed on any concrete surface where additional concrete or grout is to be placed, where concrete sealers or surface coatings are to be used, or where the concrete finish requires an integral floor product. Apply curing compound as soon as the free water on the surface has disappeared and no water sheen is visible, but not after the concrete is dry or when the curing compound can be absorbed into the concrete. Apply in compliance with the manufacturer's recommendations.

2. Specified applications of curing methods:

a. Slabs for Liquid Retaining Structures: Water curing only.

b. Slabs on Grade and Footings (not used to retain liquids): Water curing or sheet material curing or liquid membrane curing.

c. Structural Slabs (other than Liquid Retaining Structures): Water curing or liquid membrane curing.

d. Horizontal Surfaces which will Receive Additional Concrete, Coatings, Grout or Other Material that Requires Bond to the substrate: Water curing.

e. Formed Surfaces: None if nonabsorbent forms are left in place seven days. Water curing if absorbent forms are used. Water curing if forms are removed prior to seven days. Exposed horizontal surfaces of formed walls or columns shall be water cured for seven days or until next placement of concrete is made.

f. Surfaces of Concrete Joints: Water curing or sheet material curing.

3. Curing time may be reduced to 3 days for concrete placement using Type III cement when approved by the Engineer.

C. Protect finished surfaces and slabs from the direct rays of the sun to prevent checking and crazing.

D. Cold Weather Concreting

1. For this Specification, "cold weather" is defined as a period when for more than three successive days, the average daily outdoor temperature drops below 40 degrees F. Calculate average daily temperature as the average of the highest and the lowest temperature during the period from midnight to midnight.

2. Batch, deliver, place, cure and protect concrete during cold weather in compliance with the recommendations of ACI 306R and the additional requirements of this Section.

3. Review the cold weather concreting plan at the preconstruction meeting. Include the methods and procedures for use during cold weather including the production,

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transportation, placement, protection, curing and temperature monitoring of the concrete and the procedures to be implemented upon abrupt changes in weather conditions or equipment failures.

4. The minimum temperature of concrete immediately after placement and during the protection period shall be as indicated in Table 3. The temperature of the concrete in place and during the protection period shall not exceed these values by more than 20 degrees F. Prevent overheating and non-uniform heating of the concrete.

TABLE 3

Concrete Temperatures
Minimum Dimension of Section

| | ≤ 12-inch | 12- to 36-inch |
|---|---|---|
| Min. conc. temp: | 55 Degree F | 50 Degree F |

5. Protect concrete during periods of cold weather to provide continuous warm, moist curing (with supplementary heat when required by weather conditions) for a total of at least 350 degree-days of curing.

   a. Degree-days are defined as the total number of 24 hour periods multiplied by the weighted average daily air temperature at the surface of the concrete (e.g., 7 days at an average 50 degrees F = 350 degree-days).

   b. To calculate the weighted average daily air temperature, sum hourly measurements of the air temperature in the shade at the surface of the concrete taking any measurement less than 50 degrees F as 0 degrees F. Divide the sum thus calculated by 24 to obtain the weighted average temperature for that day.

6. Do not use salt, manure or other chemicals for protection.

7. At the end of the protection period, allow the concrete to cool gradually to the ambient temperature. If water curing has been used, do not expose concrete to temperatures below those shown in Table 3 until at least 24 hours after water curing has been terminated and air dry concrete for at least 3 days prior to first exposure to freezing temperatures.

8. During periods not defined as cold weather, but when freezing temperatures are expected or occur, protect concrete surfaces from freezing for the first 24 hours after placing.

E. Hot Weather Concreting

1. For this Specification, "hot weather" is defined as any combination of high air temperatures, low relative humidity and wind velocity which produces a rate of evaporation as estimated in ACI 305R, approaching or exceeding 0.2 pounds per square foot per hour (lb/sq ft/hr).

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2. Batch, deliver, place, cure and protect concrete during hot weather in compliance with the recommendations of ACI 305R and the additional requirements of this Section.

   a. Temperature of concrete being placed shall not exceed 90 degrees F. Maintain a uniform concrete mix temperature below this level. The temperature of the concrete shall not cause loss of slump, flash set or cold joints.

   b. Promptly deliver concrete to the site and promptly place the concrete upon its arrival at the site, not exceeding the maximum time interval specified in Paragraph 3.02I.4. Provide vibration immediately after placement.

   c. The Engineer may direct the Contractor to immediately cover concrete with sheet curing material.

3. Review the hot weather concreting plan at the preconstruction meeting. Include the methods and procedures for use during hot weather including production, placement, and curing.

## 3.08 REMOVAL OF FORMS

A. Do not remove forms before the concrete has attained a strength of at least 70 percent of its specified design strength for beams and slabs and at least 30 percent of its specified design strength for walls and vertical surfaces, nor before reaching the following number of day-degrees of curing (whichever is the longer):

TABLE 4

| Forms for | Degree Days |
|---|---|
| Beams and slabs | 500 |
| Walls and vertical surfaces | 100 |

(See definition of degree-days in Paragraph 3.07D)

B. Do not remove shores until the concrete has attained at least 70 percent of its specified design strength and also sufficient strength to support safely its own weight and the construction live loads upon it.

C. In cold weather, when temperature of concrete exceeds ambient air temperature by 20 Degrees F at the end of the protection period, loosen forms and leave in place for at least 24 hours to allow concrete to cool gradually to ambient air temperature.

## 3.09 FIELD AND LABORATORY TESTS

A. Sets of field control cylinder specimens will be taken by the Engineer (or Owner's testing laboratory inspector) during the progress of the work, in compliance with ASTM C31. The number of sets of concrete test cylinders taken of each class of concrete placed each day shall not be less than one set per day, nor less than one set for each 100 $yds^3$ of concrete nor less than one set for each 5,000 sq ft of surface area for slabs or walls. Specimens shall be formed in 6-inch diameter by 12-inch-long non-absorbent cylindrical molds.

   1. A "set" of test cylinders shall consist of five cylinders: one to be tested at seven days, one to be tested at 14 days, and two to be tested and their strengths averaged at 28 days.

The fifth may be used for a special test at 3 days or to verify strength after 28 days if 28 day test results are low.

2. When the average 28 day compressive strength of the cylinders in any set falls below the required compressive strength or below proportional minimum 7-day or 14-day strengths (where proper relation between seven, 14 and 28 day strengths have been established by tests), change proportions, cementitious content, or temperature conditions to achieve the required strengths at no additional cost to the Owner.

B. Cooperate in the making of tests by allowing free access to the work for the selection of samples.] Provide four firmly braced, insulated, heated, closed wooden curing boxes, each sized to hold ten specimens, complete with cold weather temperature and hot weather temperature control thermostat for initial curing and storage from time of fabrication until shipment to the testing lab. Protect the specimens against injury or loss through construction operations. Furnish material and labor required for the purpose of taking concrete cylinder samples. All shipping of specimens will be paid for by the Owner.

C. Slump tests will be made in the field by the Engineer (or Owner's testing laboratory inspector) immediately prior to placing the concrete. Such tests will be made in accordance with ASTM C143. When concrete is pumped, slump will be determined at point of truck discharge. If the slump is outside the specified range, the concrete will be rejected.

D. Test for air content will be made by the Engineer (or Owner's testing laboratory inspector) on a fresh concrete sample. Air content for concrete made of ordinary aggregates having low absorption shall be made in compliance with either the pressure method complying with ASTM C231 or by the volumetric method complying with ASTM C173. If aggregates with high absorptions are used, the latter test method shall be used. When concrete is pumped, air content will be determined at point of placement.

## 3.10 FIELD CONTROL

A. The Engineer may have cores taken from any questionable area in the concrete work such as construction joints and other locations as required for determination of concrete quality. The results of tests on such cores shall be the basis for acceptance, rejection or determining the continuation of concrete work. The right of the Engineer to take such cores shall not be construed as creating any obligation to take such cores, and not exercising this right to do so shall not relieve the Contractor from meeting the requirements of these Specifications.

B. Cooperate in obtaining cores by allowing free access to the work and permitting the use of ladders, scaffolding and such incidental equipment as may be required. Repair all core holes with non-shrink grout as specified in Section 03600. The work of cutting, testing and repairing the cores will be at the expense of the Contractor if defective work is uncovered. If no defective work is found, such cost will be at the expense of the Owner.

## 3.11 FAILURE TO MEET REQUIREMENTS

A. Should the strengths shown by the test specimens made and tested in compliance with the previous provisions fall below the values given in Table 1, the Engineer may require changes in proportions or materials, or both, to apply to the remainder of the work in accordance with Paragraph 1.05E. Furthermore, the Engineer may require additional curing on those portions of the structure represented by the test specimens which fall below the values given in Table

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1. The cost of such additional curing shall be at no additional cost to the Owner. In the event that such additional curing does not give the strength required, as evidenced by core and/or load tests, the Engineer may require strengthening or replacement of those portions of the structure which fail to develop the required strength. Coring and testing and/or load tests and any strengthening or concrete replacement required because strengths of test specimens are below that specified, shall be at no additional cost to the Owner. In such cases of failure to meet strength requirements the Contractor and Owner shall confer to determine what adjustment, if any, can be made in compliance with Sections titled "Strength" and "Failure to Meet Strength Requirements" of ASTM C94. The "purchaser" referred to in C94 is the Contractor.

B. When the tests on control specimens of concrete fall below the required strength, the Engineer will permit check tests for strengths to be made by means of typical cores drilled from the structure in compliance with ASTM C42 and C39. In cases where tests of cores fall below the values given in Table 1, the Engineer, in addition to other recourses, may require load tests on any one of the slabs, walls, beams, columns, piles, and pile caps in which such concrete was used. Test need not be made until concrete has aged 60 days. The Engineer may require strengthening or replacement of those portions of the structure which fail to develop the required strength. All coring and testing and/or load tests and any strengthening or concrete replacement required because strengths of test specimens are below that specified, shall be at no additional cost to the Owner.

C. Should the strength of test cylinders fall below 60 percent of the required minimum 28 day strength, the concrete shall be rejected and shall be removed and replaced at no additional cost to the Owner.

## 3.12 PATCHING AND REPAIRS

A. It is the intent of these Specifications to require quality work including forming, mixture and placement of concrete and curing so completed concrete surfaces will require no patching or repairs.

B. As soon as the forms have been stripped and the concrete surfaces exposed: remove fins and other projections; fill recesses left by the removal of form ties; and repair surface defects which do not impair structural strength. Clean all exposed concrete surfaces and adjoining work stained by leakage of concrete.

C. Immediately after removal of forms remove tie cones and metal portions of ties as specified in Section 03100. Fill holes promptly upon stripping as follows: Moisten the hole with water, followed by a 1/16-inch brush coat of neat cement slurry mixed to the consistency of a heavy paste. Immediately plug the hole with a 1 to 1.5 mixture of cement and concrete sand mixed slightly damp to the touch (just short of "balling"). Hammer the grout into the hole until dense, and an excess of paste appears on the surface in the form of a spider web. Trowel smooth with heavy pressure. Avoid burnishing.

D. When filling tie cone holes and patching or repairing exposed surfaces use the same source of cement and sand as used in the parent concrete. Adjust color to match by addition of white cement. Rub lightly with a fine carborundum stone at an age of one to five days if necessary to bring the surface down with the parent concrete. Do not damage or stain the virgin skin of the surrounding parent concrete. Wash thoroughly to remove all rubbed matter.

E. Defective concrete and honeycombed areas: Chip down square and at least 1 inch deep to sound concrete with hand chisels or pneumatic chipping hammers. Irregular voids or surface stones need not be removed if they are sound, free of laitance, and firmly embedded in the parent concrete. If honeycomb exists around reinforcement, chip to provide a clear space at least 3/8-inch-wide all around the steel. For areas less than 1-1/2-inch-deep, the patch may be made in the same manner as described above for filling form tie holes, care being exercised to use adequately dry (non-trowelable) mixtures and to avoid sagging. Thicker repairs will require build-up in successive 1-1/2-inch layers on successive days, each layer being applied (with slurry, etc.) as described above.

F. For very heavy (generally formed) patches, the Engineer may order the addition of pea gravel to the mixture and the proportions modified as follows:

| Material | Volumes | Weights |
|---|---|---|
| Cement | 1.0 | 1.0 |
| Sand | 1.0 | 1.0 |
| Pea Gravel | 1.5 | 1.5 |

G. The Contractor may use a pre-packaged patching compound, such as: Poly-Patch by Euclid Chemical Company; Emaco R310 by BASF Chemical Company; Sikatop 122 Plus by Sika Chemical Corporation or equal only if approved by the Engineer for use and for color match.

3.13 SCHEDULE

A. The following (Table 5) are the general applications for the various concrete classes and design strengths:

TABLE 5

| Class | Design Strength (psi) | Description |
|---|---|---|
| A | 2,500 | Concrete fill, concrete fill for bollards, electrical raceway encasement, and pipe encasement. |
| B | 3,000 | Where specified or noted. |
| E1 | 4,500 | Structural concrete foundation mats and slabs, walls, and footings 16 inches and greater in thickness. |
| E2 | 4,500 | Except as noted above for Class E1 concrete: Structural concrete greater than 10 inches in thickness. |
| E3 | 4,500 | Structural concrete 10 inches or less in thickness. |

END OF SECTION

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SECTION 03350

CONCRETE FINISHES

PART 1: GENERAL

1.01 SCOPE OF WORK

A. Furnish all labor, materials, equipment and incidentals required and finish cast-in-place concrete surfaces as specified herein.

1.02 RELATED WORK

A. Concrete and finishing for walkway and pavements is included in Division 2.

B. Concrete formwork is included in Section 03100.

C. Patching and repair of defective and honeycombed concrete is included in Section 03300.

D. Grout is included in Section 03600.

E. Modifications to existing concrete are included in Section 03740.

F. Waterproofing, dampproofing and caulking are included in Section 07005.

G. Painting, toppings and special surfaces are included in Division 9.

1.03 SUBMITTALS

A. Submit, in accordance with Section 01300, shop drawings and product data showing materials of construction and details of installation for:

1. Concrete sealer. Include catalog cuts, technical data, storage requirements, product life, working time after mixing, temperature considerations and Material Safety Data Sheet. Also submit confirmation that the sealer is compatible with additionally applied coatings.

2. Chemical hardener. Include catalog cuts, technical data, storage requirements, product life, working time after mixing, temperature considerations and Material Safety Data Sheet. Also submit confirmation that the hardener is compatible with sealer.

1.04 REFERENCE STANDARDS

A. American Society for Testing and Materials (ASTM)

1. ASTM C144 - Standard Specification for Aggregate for Masonry Mortar.

B. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.05 QUALITY ASSURANCE

A. Services of Manufacturer's Representative

1. Make available at no additional cost to the Owner, upon 72 hours notification, the services of a qualified field representative of the manufacturer of sealer or hardener to instruct the Contractor on the proper application of the product under prevailing job conditions.

1.06 RESPONSIBILITY FOR CHANGING FINISHES

A. The surface finishes specified for concrete to receive coatings or other finish materials are those required for the proper application of the products specified under other Sections. Where products different from those specified are approved for use determine if changes in finishes are required and provide the proper finishes to receive these products.

B. Perform changes in finishes made to accommodate products different from those specified at no additional cost to the Owner. Submit the proposed new finishes to the Engineer for approval.

PART 2: PRODUCTS

2.01 MATERIALS

A. Cementitious and component materials required for finishing concrete surfaces: As specified in Section 03300.

B. Chemical hardener: Lapidolith by BASF Building Systems; Hornolith by Tamms; Surfhard by the Euclid Chemical Co. or equal fluosilicate base material.

C. Concrete sealer: "Kure-N-Seal", by BASF Building Systems or equal acrylic sealer.

PART 3: EXECUTION

3.01 FORMED SURFACES

A. Form removal: Conform to Sections 03100 and 03300.

B. Do not damage edges or obliterate the lines of chamfers, rustications or corners when removing the forms or doing any other work adjacent thereto.

C. Clean all exposed concrete surfaces and adjoining work stained by leakage of concrete.

D. Off-Form Finish

1. Remove fins and other projections and fill tie cones and defects as specified in Section 03300.

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E. Rubbed Finish

1. Immediately upon stripping forms and before concrete changes color, carefully remove all fins with a hammer. While the surface is still damp apply a thin coat of medium consistency neat cement slurry using bristle brushes to provide a bonding coat within all pits, air holes or blemishes in the parent concrete. Do not coat large areas of the surface with this slurry.

2. Before the slurry dries or changes color, apply a dry (almost crumbly) grout consisting of one volume cement to 1-1/2 volumes of clean masonry sand having a fineness modulus of approximately 2.25 and complying with the gradation requirements of ASTM C144. Apply grout uniformly using damp (neither dripping wet nor dry) pads of coarse burlap approximately 6-inch square used as a float. Scrub grout into the pits and air holes to provide a dense mortar in the imperfections to be patched.

3. Allow the mortar to partially harden for one or two hours depending upon the weather. If the air is hot and dry, keep the surface damp during this period using a fine, fog spray. When the grout has hardened sufficiently so it can be scraped from the surface with the perpendicular edge of a steel trowel without damaging the grout in the small pits or holes, cut off all grout that can be removed with a trowel. Grout allowed to remain on the surface too long will get too hard and will be difficult to remove.

4. Allow the surface to dry and rub it vigorously with clean dry burlap to completely remove any dried grout. No visible film of grout should remain after this rubbing. The entire cleaning operation for any area must be completed the day it is started. Do not leave grout on surfaces overnight. Allow grout to dry after it has been cut off with the trowel so it can be wiped off clean with the burlap.

5. On the day following the repair of pits, air holes and blemishes, the surfaces again shall be wiped off clean with dry, used pieces of burlap containing old hardened mortar which will act as a mild abrasive. After this treatment, there shall be no built-up film remaining on the parent surface. If, however, a built-up film remains, use a fine abrasive stone to remove all such material without breaking through the surface film of the original concrete. Scrub lightly to remove excess material without working up a lather or mortar or changing the texture of the concrete.

6. Follow the final bagging or stoning operation with a thorough wash-down with stiff bristle brushes to remove extraneous materials from the surface. Spray the surface with a fine fog spray periodically to maintain a continually damp condition for at least 3 days after the application of the repair grout.

7. The Rubbed Finish application may be deleted by the Engineer if the unfinished concrete surface is of superior quality and without surface voids.

3.02 FLOORS AND SLABS

A. Consider the potential for longer setting time in concrete containing fly ash.

B. Compact with internal vibrators as specified in Section 03300 and screed to the established grades. Provide floors and slabs level with a tolerance of 1/8 inch when checked with a 12-ft straightedge, except where drains occur, in which case pitch floors to drains as indicated.

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Failure to meet either of above shall be cause for removal, grinding, or other correction as directed by the Engineer, at no additional cost to the Owner.

C. Following screeding as specified above, float the slabs as approved by the Engineer. Continue floating operation until sufficient mortar is brought to the surface to fill all voids. Test the surfaces with a straightedge to detect high and low spots which shall be eliminated. Do not overwork the concrete as evidenced by excess water and fine material on the surface.

D. Do not use "jitterbugs" or other special tools designed for the purpose of forcing the coarse aggregate away from the surface and allowing a layer of mortar to accumulate on any slab finish. Do not dust surfaces with dry materials. Round off all edges of slabs and tops of walls with a steel edging tool. Use steel edging tool with radius of 1/4-in. for all slabs subject to wheeled traffic.

E. Measure floor flatness the day after a concrete floor is finished and before the shoring is removed, in order to eliminate any effects of shrinkage, curling and deflection. A 12-ft-long straightedge shall be supported at each end with steel gauge blocks whose thickness are equal to tolerance specified. Floor surface shall not have crowns so high as to prevent 12-ft straightedge from resting on the two end blocks, nor low spots so low that a third block of twice the tolerance in thickness can pass under the supported straightedge. Compliance with the designated limits in four of five consecutive measurements will confirm compliance, unless obvious faults are observed. A check for adequate slope and drainage will also be made to confirm compliance.

F. Descriptions

1. Steel Trowel Finish. Finish by screeding and floating with straightedges to bring the surfaces to the elevations indicated. While the concrete is still green, but sufficiently hardened to bear a person's weight without deep imprint, the surface shall be wood floated to a true, even plane with no coarse aggregate visible. Apply sufficient pressure on the wood floats to bring moisture to the surface. After surface moisture has disappeared, hand steel trowel to produce a smooth, impervious surface, free from trowel marks. Trowel the surface again for the purpose of burnishing. The final troweling shall produce a ringing sound from the trowel. Do not use dry cement or additional water in troweling.

2. Wood Float Finish. Finish by screeding with straightedges to bring the surfaces to the elevations indicated. Use a wood float to compact and seal surface. Remove all laitance and leave a clean surface.

3. Light Broomed Finish. Steel trowel finish the concrete, as specified above but omit the final troweling and finish the surface by drawing a fine-hair broom lightly across the surface. Broom in the same direction and parallel to expansion joints, or in the case of inclined slabs, perpendicular to the slope, or except as directed otherwise.

4. Broomed Finish. Steel trowel finish the concrete, as specified above but omit the final troweling. While the concrete is still soft enough, finish the surface with a stiff coarse fiber broom to produce the pattern and depth of scoring as approved by the Engineer.

5. Power Machine Finish. In lieu of hand steel trowel finishing, an approved power machine for finishing concrete floors and slabs may be used in accordance with the directions of

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the machine manufacturer and as approved by the Engineer. Do not use a power machine until the concrete has attained the necessary set to allow finishing without introducing high and low spots in the slab. Hand steel trowel the areas of slabs not accessible to power equipment. Provide a final steel troweling done by hand over all areas.

G. Concrete Sealer

1. Prepare and seal surfaces [indicated on the Drawings to receive a sealer] as follows:

a. Finish concrete as specified in the preceding paragraphs and in accordance with the Schedule of Finishes in Paragraph 3.05 below.

b. Newly Placed Concrete: Surface must be sound and properly finished. Surface is application-ready when it is damp but not wet and can no longer be marred by walking workers.

c. Newly Cured Bare Concrete: Level any spots gouged out by trades. Remove all dirt, dust, droppage, oil, grease, asphalt and foreign matter. Cleanse with caustics and detergents as required. Rinse thoroughly and allow to dry so that surface is no more than damp, and not wet.

d. Existing Concrete: Restore surface soundness by patching, grouting, and filling cracks and holes. Surface must also be free of any dust, dirt and other foreign matter. Use power tools and/or strippers to remove any incompatible sealers or coatings. Cleanse as required, following the procedure indicated under cured concrete.

e. Application: Apply sealer so as to form a continuous, uniform film by spray, soft bristle push broom, long nap roller, lambs' wool applicator, or ordinary garden-type sprayers.

f. For curing only, two coats are required. Apply first coat evenly and uniformly as soon as possible after final finishing at the rate of 200 to 400 sq ft per gallon. Apply second coat when all trades are completed and structure is ready for occupancy at the rate of 400 to 600 sq ft per gallon.

g. To seal and dustproof, two coats are required. For sealing new concrete, both coats shall be applied full-strength. On aged concrete, when renovating, dust proofing and sealing, the first coat should be thinned 10 to 15 percent with reducer per manufacturer's directions.

## 3.03 CONCRETE RECEIVING CHEMICAL HARDENER

A. After 28 days, minimum, concrete cure, apply chemical hardener in three applications to a minimum total coverage of the undiluted chemical of 100 sq ft per gallon and in accordance with manufacturer's recommendations as reviewed.

## 3.04 APPROVAL OF FINISHES

A. All concrete surfaces, when finished, will be inspected by the Engineer.

B. Refinish or rework unsatisfactory finishes until approved by the Engineer, at no additional cost to the Owner.

C. Hardened unsatisfactory finishes will require removal, grinding, or other appropriate correction approved by the Engineer, at no additional cost to the Owner.

3.05 SCHEDULE OF FINISHES

A. Finish concrete in the various specified manners either to remain as natural concrete or to receive an additional applied finish or material under another Section. Where products different from those specified are approved for use comply with the requirements of Paragraphs 1.06A and 1.06B.

B. Finishes to the base concrete for the following conditions shall be as scheduled below and as further specified herein:

1. Exposed exterior concrete excluding slabs and walking surfaces - Rubbed finish. (Rub open tank walls above and to 1-ft below normal water line).

2. Concrete for exterior on stairs and other horizontal areas - Broomed finish, non-slip.

3. Exposed interior concrete including underside slabs, beams and stairs and sides of openings, beams and stairs - Rubbed finish.

4. Concrete for interior walking surfaces excluding stairs – wood float finish.

5. Concrete for interior stairs and metal pan stairs - Light broomed finish, non-slip.

6. Walls of open topped tanks - Rubbed finish above and to 1-ft below normal water line. Off-form finish from 1-ft below normal water line to base of wall.

7. Concrete stairs, landings and platforms below normal water level in liquid retaining structures – Broomed finish, non-slip.

8. Tops of curbs and pads - Steel trowel finish.

9. Concrete on which liquids flow or are contained - Steel troweled finish.

10. Ribbed Concrete - Off-form finish.

11. Concrete not exposed in the finished work and not scheduled to receive an additional applied finish or material - Off-form finish at vertical surfaces, consolidate and screed to grade at horizontal surfaces.

12. Concrete tank bottoms to be covered with grout - Broom finish as approved. See Section 03600 for additional requirements.

13. Concrete to receive dampproofing - Off-form finish.

14. Concrete to receive capillary waterproofing - Off-form finish at vertical and overhead surfaces, light broomed finish at horizontal surfaces.

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15. Concrete to receive cementitious slurry waterproofing - Off-form finish at vertical surfaces, light broomed finished horizontal surfaces.

16. Concrete to receive chemical hardener - Light broomed finish, non-slip, except at electrical rooms and areas and generator room provide wood float, non-slip.

17. Concrete to receive paint - Rubbed finish.

18 Concrete to receive floor sealer - See Paragraph 3.02G above.

19. Concrete to have an abrasive blast finish - See Paragraph 3.01F above.

20. Concrete to receive seamless flooring - Once-over steel trowel finish.

21. Concrete to receive ceramic and quarry tile - Broomed finish as approved.

22. Concrete to receive vinyl and rubber surfacing and carpet - Steel trowel finish.

23. Concrete to receive rubberized asphalt sheet membrane waterproofing - Wood float finish at horizontal surfaces; rubbed finish at vertical surfaces.

24. Concrete to receive roof insulation - Consolidate, screed and wood float to required grades.

END OF SECTION

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# SECTION 03600

# GROUT

## PART 1: GENERAL

### 1.01 SCOPE OF WORK

A. Furnish all labor, materials, equipment and incidentals required and install grout complete as shown on the Drawings and as specified herein.

### 1.02 RELATED WORK

A. Grout for rock anchors is included in Division 2.

B. Concrete formwork is included in Section 03100.

C. Concrete reinforcement is included in Section 03200.

D. Concrete joints and joint accessories are included in Section 03250.

E. Cast-in-place concrete is included in Section 03300.

F. Modifications to existing concrete are included in Section 03740.

G. Miscellaneous metals are included in Section 05500.

### 1.03 SUBMITTALS

A. Submit, in accordance with Section 01300, shop drawings and product data showing materials of construction and details of surface preparation, mixing and installation for:

1. Commercially manufactured non-shrink cementitious grout. Include catalog cuts, technical data, storage requirements, product life, working time after mixing, temperature considerations, conformity to the specified ASTM standards, and Material Safety Data Sheet.

2. Commercially manufactured non-shrink epoxy grout. Include catalog cuts, technical data, storage requirements, product life, working time after mixing, temperature considerations, conformity to the specified ASTM standards, and Material Safety Data Sheet.

3. Cement grout. Include the type and brand of cement, the gradation of fine aggregate, product data on any proposed admixtures and the proposed grout mix.

4. Concrete grout. Include data as required for concrete as delineated in Section 03300 and for fiber reinforcement as delineated in Section 03200.

B. Samples

1. Submit samples of commercially manufactured grout products when requested by the Engineer.

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2. Submit samples of aggregates proposed for use in grout mixes when requested by the Engineer.

C. Laboratory Test Reports

1. For concrete grout, submit laboratory test data as required for concrete as delineated in Section 03300.

D. Qualifications

1. Submit documentation that grout manufacturers have a minimum of at least 10 years experience in the production and use of the grouts proposed.

1.04 REFERENCE STANDARDS

A. American Society for Testing and Materials (ASTM)

1. ASTM C33 - Standard Specification for Concrete Aggregates.

2. ASTM C150 - Standard Specification for Portland Cement.

3. ASTM C531 - Standard Test Method for Linear Shrinkage and Coefficient of Thermal Expansion of Chemical-Resistant Mortars, Grouts and Monolithic Surfacings and Polymer Concretes.

4. ASTM C579 - Standard Test Methods for Compressive Strength of Chemical-Resistant Mortars, Grouts, Monolithic Surfacings and Polymer Concretes.

5. ASTM C827 - Standard Test Method for Change in Height at Early Ages of Cylindrical Specimens of Cementitious Mixtures.

6. ASTM C1077 - Standard Practice for Laboratories Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Laboratory Evaluation.

7. ASTM C1107 - Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Non-shrink).

8. ASTM E329 - Standard specification for agencies engaged in the testing and/or inspection of materials used in construction.

B. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.05 QUALITY ASSURANCE

A. Qualifications

1. Grout manufacturers shall have a minimum of 10 years' experience in the production and use of the type of grout proposed.

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B. Field Testing

1. All field testing and inspection services will be provided by the Owner. Assist in the sampling of materials, and cooperate by allowing free access to the work and permitting the use of ladders, scaffolding, and such incidental equipment as may be required. Methods of testing will comply with the applicable ASTM Standards.

2. Field testing of concrete grout will be as specified for concrete in Section 03300.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to the jobsite in original, unopened packages, clearly labeled with the manufacturer's name, product identification, batch numbers and printed instructions.

B. Store materials in full compliance with the manufacturer's recommendations. Limit total storage time from date of manufacture to date of installation to six months or the manufacturer's recommended storage time, whichever is less.

C. Remove immediately from the site material which becomes damp, contains lumps, or is hardened and replace with acceptable material at no additional cost to the Owner.

D. Deliver non-shrink cementitious grout as a pre-portioned blend in prepackaged mixes requiring only the addition of water.

E. Deliver non-shrink epoxy grout as a pre-proportioned, prepackaged, three component system requiring only mixing as directed by the manufacturer.

1.07 DEFINITIONS

A. Non-shrink Grout: A commercially manufactured product that does not shrink in either the plastic or hardened state, is dimensionally stable in the hardened state and bonds to a clean base plate.

PART 2: PRODUCTS

2.01 GENERAL

A. The use of a manufacturer's name and product or catalog number is for the purpose of establishing the standard of quality desired.

B. Like materials shall be the products of one manufacturer or supplier in order to provide standardization of appearance.

2.02 MATERIALS

A. Non-shrink Cementitious Grout

1. Non-shrink cementitious grouts: Conform to ASTM C1107. Grouts shall be Portland cement based, contain a pre-proportioned blend of selected aggregates and shrinkage compensating agents and require only the addition of water. Non-shrink cementitious grouts shall not contain expansive cement or metallic particles. The grouts shall exhibit no shrinkage when tested in conformity with ASTM C827.

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a. General purpose non-shrink cementitious grout: Conform to the standards stated above. SikaGrout 212 by Sika Corp.; Set Grout by BASF Building Systems; NS Grout by The Euclid Chemical Co.; Five Star Grout by Five Star Products, Inc., or equal.

b. Flowable (Precision) non-shrink cementitious grout: Conform to the standards stated above. Masterflow 928 by BASF Building Systems; Hi-Flow Grout by The Euclid Chemical Co.; SikaGrout 212 by Sika Corp.; Five Star Grout by Five Star Products, Inc., or equal.

B. Non-shrink Epoxy Grout

1. Non-shrink epoxy grout: Grout shall be pre-proportioned, prepackaged, three components, 100 percent solids system consisting of epoxy resin, hardener and blended aggregate. It shall have a compressive strength of 10,000 psi in 7 days when tested in conformity with ASTM C579 and have a maximum coefficient of thermal expansion of $30 \times 10^{-6}$ in/in/degrees F when tested in conformity with ASTM C531. Masterflow 648 CP by BASF Building Systems; Five Star HP Epoxy Grout by Five Stars Products, Inc; Sikadur 42 Grout-Pak by Sika Corp.; $E^3$-G Epoxy Grout by the Euclid Chemical Co. or equal.

C. Cement Grout

1. A mixture of one part Portland cement conforming to ASTM C150, Type I, II, or III and one to two parts sand conforming to ASTM C33 with sufficient water to place the grout. The water content shall be sufficient to impart workability to the grout but not to the degree that it will allow the grout to flow.

D. Concrete Grout

1. Conform to the requirements of Section 03300 except as specified herein. Proportion with Type II cement, coarse and fine aggregates, water, water reducing admixture and air entraining agent to produce a mix having an average strength of 3500 psi at 28 days (2500 psi nominal strength). Coarse aggregate size shall be 3/8-in. maximum. Slump shall not exceed 5-in. Minimum cement content shall be 540 lbs per cubic yard and maximum water to cement ratio shall be 0.45.

2. Add synthetic reinforcing fibers as specified in Section 03200 to the concrete grout mix at the rate of 1.5 lbs of fibers per cubic yard of grout. Add fibers from the manufacturer's pre-measured bags and according to the manufacturer's recommendations to ensure complete dispersion of the fiber bundles as single monofilaments within the concrete grout.

E. Water

1. Potable water free of oil, acid, alkali, salts, chlorides (except those attributable to drinking water), organic matter, or other deleterious substances.

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PART 3: EXECUTION

3.01 PREPARATION

A. Place grout where indicated or specified over existing concrete and cured concrete which has attained its specified design strength unless otherwise approved by the Engineer.

B. Concrete surfaces to receive grout shall be clean and sound; free of ice, frost, dirt, dust, grease, oil, form release agent, laitance and paints and free of all loose material or foreign matter which may affect the bond or performance of the grout.

C. Roughen concrete surfaces by chipping, sandblasting, or other dry mechanical means to bond the grout to the concrete. Remove loose or broken concrete. Irregular voids or projecting coarse aggregate need not be removed if they are sound, free of laitance and firmly embedded into the parent concrete.

1. Air compressors used to clean surfaces in contact with grout shall be the oil-less type or equipped with an oil trap in the airline to prevent oil from being blown onto the surface.

D. Remove all loose rust, oil or other deleterious substances which may affect the bond or performance of the grout from metal embedments or bottom of base plates prior to the installation of the grout.

E. Wash concrete surfaces clean and then keep moist for at least 24 hours prior to the placement of non-shrink cementitious or cement grout. Saturation may be achieved by covering the concrete with saturated burlap bags, use of a soaker hose, flooding the surface or other method acceptable to the Engineer. Upon completion of the 24 hour period, remove visible water from the surface prior to grouting.

F. Non-shrink epoxy grouts do not require saturation of the concrete substrate. Do not wet concrete surfaces to receive non-shrink epoxy grout. Surfaces in contact with epoxy grout shall be completely dry before grouting.

G. Provide forms for grout. Line or coat forms with release agents recommended by the grout manufacturer. Provide forms anchored in place and shored to resist the forces imposed by the grout and its placement.

1. Forms for all grout other than concrete grout shall be designed to allow the formation of a hydraulic head and shall have chamfer strips built into forms.

H. Level and align the structural or equipment bearing plates in accordance with the structural requirements or the recommendations of the equipment manufacturer, as applicable.

I. Support equipment during alignment and installation of grout by shims, wedges, blocks or other approved means. The shims, wedges and blocking devices shall be prevented from bonding to the grout by bond breaking coatings and removed after grouting unless otherwise approved by the Engineer. Grout voids created by the removal of shims, wedges and blocks.

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3.02 INSTALLATION - GENERAL

A. Mix, apply and cure products in strict compliance with the manufacturer's recommendations and these Specifications.

B. Provide staffing and equipment available for rapid and continuous mixing and placing. Keep all necessary tools and materials ready and close at hand.

C. Maintain temperatures of the base plate, supporting concrete, and grout between 40 and 90 degrees F during grouting and for at least 24 hours after placement, until grout compressive strength reaches 1000 psi or as recommended by the grout manufacturer, whichever is longer. Do not allow differential heating or cooling of base plates and grout during the curing period.

D. Take special precautions for hot weather or cold weather grouting as recommended by the manufacturer when ambient temperatures and/or the temperature of the materials in contact with the grout are outside of the 40 to 90 degrees F range.

E. Install grout to preserve the isolation between the elements on either side of the joint where grout is placed in the vicinity of an expansion or control joint.

F. Reflect all existing underlying expansion, control and construction joints through the grout.

3.03 INSTALLATION - NON-SHRINK CEMENTITIOUS GROUTS AND CEMENT GROUTS

A. Mix in accordance with manufacturer's recommendations. Do not add cement, sand, pea gravel or admixtures without prior approval by the Engineer.

B. Do not mix by hand. Mix in a mortar mixer with moving blades. Pre-wet the mixer and empty excess water. Add pre-measured amount of water for mixing, followed by the grout. Begin with the minimum amount of water recommended by the manufacturer and then add the minimum additional water required to obtain workability. Do not exceed the manufacturer's maximum recommended water content.

C. Placements greater than 3-in. in depth shall include the addition of clean, washed pea gravel to the grout mix when approved by the manufacturer. Comply with the manufacturer's recommendations for the size and amount of aggregate to be added.

D. Provide forms as specified in Paragraph 3.01G. Place grout into the designated areas and prevent segregation and entrapment of air. Do not vibrate grout to release air or to consolidate the material. Fill all spaces and provide full contact between the grout and adjoining surfaces. Provide grout holes and vent holes as necessary.

E. Place grout rapidly and continuously to avoid cold joints. Do not place grout in layers. Do not add additional water to the mix (re-temper) after initial stiffening.

F. Just before the grout reaches its final set, cut back the grout to the substrate at a 45 degree angle from the lower edge of bearing plate unless otherwise ordered and approved by the Engineer. Finish this surface with a wood float or brush finish.

G. Begin curing immediately after form removal, cutback, and finishing. Keep grout moist and within its recommended placement temperature range for at least 24 hours after placement, until grout compressive strength reaches 1000 psi or as recommended by the manufacturer,

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whichever is longer. Saturate the grout surface by use of saturated burlap bags, soaker hoses or ponding. Provide sunshades. If drying winds inhibit the ability of a given curing method to keep grout moist, erect wind breaks until wind is no longer a problem or curing is finished.

3.04 INSTALLATION – NON-SHRINK EPOXY GROUTS

A. Mix in accordance with manufacturer's recommendations. Mix full batches only, to maintain proper proportions of resin, hardener and aggregate. Do not vary the ratio of components or add solvent to change the consistency of the grout mix. Do not over mix. Do not entrain air bubbles by mixing too quickly.

B. Monitor ambient weather conditions and contact the grout manufacturer for special placement procedures to be used for temperatures below 60 or above 90 degrees F.

C. Place grout rapidly and continuously to avoid cold joints. Place grout in lifts in accordance with manufacturer's recommendations.

D. Provide forms as specified in Paragraph 3.01G. Place grout into the designated areas and prevent entrapment of air. Fill all spaces and provide full contact between the grout and adjoining surfaces. Provide grout holes and vent holes as necessary.

E. Minimize "shoulder" length (extension of grout horizontally beyond base plate). In no case shall the shoulder length of the grout be greater than the grout thickness.

F. Finish grout by puddling to cover all aggregate and provide a smooth finish. Break bubbles and smooth the top surface of the grout in conformity with the manufacturer's recommendations.

G. Epoxy grouts are self curing and do not require the application of water. Maintain the formed grout within its recommended placement temperature range for at least 24 hours after placement, until grout compressive strength reaches 1000 psi or as recommended by the manufacturer, whichever is longer.

H. Provide grout control joints as indicated on the Drawings.

3.05 INSTALLATION - CONCRETE GROUT

A. Inspect slabs finished under Section 03350 and scheduled to receive concrete grout. Scarify existing slab surfaces to receive concrete grout. Protect and keep the surface clean until placement of concrete grout.

B. Remove debris and clean the surface by sweeping and vacuuming of all dirt and other foreign materials. Pressure wash the surface. Do not flush debris into tank drain lines.

C. Saturate the concrete surface for at least 24 hours prior to placement of the concrete grout by use of saturated burlap bags, soaker hoses or ponding. Remove excess water just prior to placement of the concrete grout. Place a cement slurry immediately ahead of the concrete grout so that the slurry is moist when the grout is placed. Work the slurry over the surface with a broom until it is coated with approximately 1/16 to 1/8-in. thick cement paste.

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D. Place concrete grout to final grade using the scrapers of the installed mechanical equipment as a guide for surface elevation and to eliminate high and low spots. Unless specifically approved by the equipment manufacturer, mechanical scraper mechanisms powered by their motors shall not be used as a finishing machine or screed to push grout.

E. Provide grout control joints as indicated on the Drawings.

F. Steel trowel finish as specified in Section 03350. Cure the concrete grout as specified for cast-in-place concrete in Section 03300.

3.06 SCHEDULE

A. The following list indicates where the particular types of grout are to be used:

1. General purpose non-shrink cementitious grout: Use at all locations where non-shrink grout is indicated on the Drawings, except for base plates greater in area than 3-ft wide by 3-ft long.

2. Flowable (precision) non-shrink cementitious grout: Use under all base plates greater in area than 3-ft wide by 3-ft long. Use at all locations indicated on the Drawings to receive flowable non-shrink grout. Flowable (precision), non-shrink, cementitious grout may be substituted for general purpose non-shrink cementitious grout.

3. Non-shrink epoxy grout: Use at all locations specifically indicated on the Drawings to receive non-shrink epoxy grout.

4. Cement grout: Use where indicated on the Drawings.

5. Concrete grout: Use for overlaying the base concrete under scraper mechanisms of clarifiers as indicated on the Drawings. Use for concrete grout fill within liquid retaining structures and other locations where specifically indicated on the Drawings.

END OF SECTION

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SECTION 03650

FLOWABLE FILL

PART 1: GENERAL

1.01 SCOPE OF WORK

A. Furnish all labor, materials, equipment and incidentals required and install all flowable fill complete as shown on the Drawings and as specified herein.

1.02 RELATED WORK

A. Cast-In-Place Concrete 03300.

1.03 SUBMITTALS

A. Submit, in accordance with Section 01300, shop drawings and product data. Submittals shall include the following:

1. Constituent quantities per cubic yard of the flowable fill mix including water content, cement factor, type and amount of fly ash and type and manufacturer of cement.

2. Technical data on all materials and components.

B. Test Reports

1. Sieve analysis of aggregate.

2. Laboratory test results of the compressive strength of the proposed mix.

1.04 REFERENCE STANDARDS

A. American Society for Testing and Materials (ASTM)

1. ASTM C33 - Standard Specification for Concrete Aggregates.

2. ASTM C94 - Standard Specification for Ready Mixed Concrete.

3. ASTM C143 - Standard Test Method for Slump of Hydraulic Cement Concrete.

4. ASTM C150 - Standard Specification for Portland Cement.

5. ASTM C618 - Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Concrete.

6. ASTM D4832 - Standard Test Method for Preparation and Testing of Controlled Low Strength Material Test Cylinders.

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B. American Concrete Institute (ACI)

1. ACI 301 - Standard Specification for Structural Concrete.

C. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.05 QUALITY ASSURANCE

A. All testing and inspection services required, unless otherwise specified, shall be provided and paid for by the Owner. Testing necessary to establish the mix shall be performed by and at the expense of the Contractor. Methods of testing shall comply with the latest applicable ASTM Methods except as specified herein.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Products shall be stored in conformity with the manufacturer's recommendations.

B. Fly ash, aggregate and cement shall be stored or stockpiled in conformity with the recommendations of ACI 301.

PART 2: PRODUCTS

2.01 GENERAL

A. The use of manufacturer's name and model or catalog number is for the purpose of establishing the standard of quality and general configuration desired.

B. Materials shall comply with this Section and any applicable State or local requirements.

2.02 MATERIALS

A. Cement shall be domestic Portland cement conforming to ASTM C150, Type II. The minimum cement content shall be 100 lbs/cu yd.

B. Fly ash shall conform to ASTM C618, Class C or Class F. The minimum fly ash content shall be 300 lbs/yd$^3$.

C. Aggregate shall be inert natural sand conforming to the requirements of ASTM C33 or inert natural sand containing aggregate sizes not greater than 3/8-in. and having given satisfactory flowability, strength and setting time when used in comparable flowable fill mixes. Aggregates shall not be expansive or reactive.

D. Water shall be potable, clean and free from injurious amounts of oils, acids, alkalis, organic matter, or other deleterious substances. The water content of the mix may be approximately 400 lbs/yd$^3$.

E. Admixtures manufactured specifically manufactured for use in flowable fills will be considered for approval. Admixtures shall be free of chlorides and alkalis (except for those attributable to water). Admixtures shall be compatible with the mix and shall be suitable for

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use in contact with potable water after curing. Admixtures causing retarded or accelerated setting of the mix shall not be used without written approval from the Engineer.

F. The unit weight of the flowable fill shall be not less than 100 pounds per cubic foot except for the mix to be used as fill material in the wet well of the Settled Sewage Pump Station. A lightweight mix with a density no greater than 75 pounds per cubic foot shall be used for this location. High entrained air and/or lightweight aggregate may be used in the lightweight mix.

2.03 MIXES

A. Select proportions of ingredients to meet the minimum design strength of 300 psi and to produce a fill having proper placability, durability and strength. Proportion ingredients to produce a homogenous mixture which will readily work into corners and angles without permitting materials to segregate.

B. Compression Tests: Furnish testing of the proposed mix to demonstrate compliance with the compression strength requirements.

C. Slump of the mix, as measured by ASTM C143, shall be approximately 8-in.

2.04 MEASURING, BATCHING, MIXING AND TRANSPORTING

A. Measuring, batching, mixing and transporting shall conform to ASTM C94 and the requirements herein or as otherwise approved in writing by the Engineer.

B. Ready-mixed flowable fill, whether produced by a concrete supplier or the Contractor shall conform to the requirements above. No hand mixing will be permitted.

C. The flowable fill shall be mixed until there is uniform distribution of the materials and shall be discharged completely before the mixer is recharged. Fill which has been remixed or retempered shall be rejected.

PART 3: EXECUTION

3.01 INSPECTION AND COORDINATION

A. The batching, mixing, transporting and placing and of the flowable fill shall be subject to the inspection of the Engineer at all times. No placement shall be made without the inspection and acceptance of the preparations by the independent inspector.

3.02 APPEARANCE

A. The flowable fill shall have a homogeneous structure which, when hardened, will have the required strength and durability.

3.03 PLACING

A. No flowable fill shall be placed until the condition of subgrade and method of placement have been approved by the Engineer. Before depositing flowable fill, all debris and foreign matter shall be removed from the excavation. Flowable fill shall not be placed in water or

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submerged within 24 hours after placing, nor shall running water be permitted to flow over the surface of fresh flowable fill.

B. Deposit the mix as near its final position as possible to avoid segregation due to rehandling or flowing. Pumping of the mix will be permitted when the approved design mix is based on pumping. Do not deposit concrete which has partially hardened or has been contaminated by foreign materials.

3.04 CURING AND PROTECTION

A. Protect all flowable fill against injury from the elements and damage of any nature during construction operations.

B. Flowable fill placed during cold weather shall be protected against freezing by methods specified in Section 03300. Salt, manure or other chemicals shall not be used for cold weather protection.

3.05 FIELD TESTS

A. Sets of 6-in. by 12-in. test cylinders will be taken of the work by the construction manager following the procedures given in ASTM D4832. The number of sets of test cylinders shall be at the discretion of the construction manager. The cylinders shall be capped with neoprene for testing. When the average compressive strength of the cylinders in any set falls below the required compressive strength; the construction manager may reject the fill represented by the set of cylinders or require modification of the proportions of the design mix to achieve the required strengths.

B. Cooperate in the making of tests by allowing free access to the work for the selection of samples, providing an insulated closed curing box for specimens, affording protection to the specimens against injury or loss through the operations and furnishing material and labor required for the purpose of taking test cylinder samples. All shipping of specimens will be paid for by the Owner.

C. Slump tests will be made in the field by the construction manager in conformity with ASTM C143.

END OF SECTION

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SECTION 03740

# MODIFICATIONS TO EXISTING CONCRETE

## PART 1: GENERAL

### 1.01 SCOPE OF WORK

A. Furnish all labor, materials, equipment and incidentals required and cut, repair or otherwise modify parts of existing concrete structures or appurtenances as shown on the Drawings and as specified herein.

B. Work under this Section shall also include bonding new concrete to existing concrete.

C. No existing structure or concrete shall be shifted, cut, removed, or otherwise altered until authorization is given by the Engineer.

D. When removing materials or portions of existing structures and when making openings in existing structures, all precautions shall be taken and all necessary barriers, shoring and bracing and other protective devices shall be erected to prevent damage to the structures beyond the limits necessary for the new work, protect personnel and to prevent damage to the structures or contents by falling or flying debris. Unless otherwise permitted, shown or specified, line drilling will be required in cutting existing concrete.

### 1.02 RELATED WORK

A. Demolition of existing structures is included in Section 02050.

B. Excavation and backfill are included in Division 2.

C. Concrete, concrete reinforcement and accessories are included in Division 3.

### 1.03 REFERENCE STANDARDS

A. American Society for Testing and Materials (ASTM)

1. ASTM C881 - Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete.

2. ASTM C882 - Standard Test Method for Bond Strength of Epoxy-Resin Systems Used with Concrete by Slant Sheer.

3. ASTM C883 - Standard Test Method for Effective Shrinkage of Epoxy-Resin Systems Used with Concrete.

4. ASTM D570 - Standard Test Method for Water Absorption of Plastics.

5. ASTM D638 - Standard Test Method for Tensile Properties of Plastics.

6. ASTM D695 - Standard Test Method for Compressive Properties of Rigid Plastics.

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7. ASTM D732 - Standard Test Method for Shear Strength of Plastics by Punch Tool.

8. ASTM D790 - Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.

B. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

PART 2: PRODUCTS

2.01 MATERIALS

A. Bonding Compound

1. General

a. The bonding compound shall be a two-component, solvent-free, moisture insensitive epoxy resin material suitable for use as a bonding adhesive to bond fresh, plastic concrete to clean, sound hardened concrete and for grouting bolts and the bonding of mating materials.

2. Material

a. The epoxy material shall conform to the following requirements:

1) Component A - Component A shall be a modified epoxy resin of the epichlorohydrin bisphenol A type containing suitable viscosity control agents. It shall not contain butyl glycidyl ether.

2) Component B - Component B shall be primarily a reaction product of a selected amine blend with an epoxy resin of the epichlorohydrin bisphenol A type containing suitable viscosity control agents, pigments and accelerators.

3) The ratio of Component B:A shall be 1:1 by volume.

4) The material shall not contain asbestos.

b. Properties of the mixed material*

1) Pot Life - 25 to 35 minutes

2) Tack-Free Time to Touch (20 mil thickness) - 3 to 5 hours

3) Initial Viscosity (Brookfield Viscometer Spindle No. 3; Speed 100) - 1900 to 3700 cps

4) Color - Gray

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c. Properties of the cured material*

1) Compressive Properties (ASTM D695) at 28 days

a) Compressive Strength - 8500 psi minimum

b) Modulus of Elasticity - 375,000 psi minimum

2) Tensile Properties (ASTM D638) at 14 days

a) Tensile Strength - 4000 psi minimum

b) Elongation at Break - 1.5 to 2.25 percent

c) Modulus of Elasticity - 275,000 psi minimum

3) Flexural Properties (ASTM D790) at 14 days

a) Flexural Strength (Modulus of Rupture) - 6300 psi minimum

b) Tangent Modulus of Elasticity in Bending - 400,000 psi minimum

4) Shear Strength (ASTM D732) at 14 days

a) Shear Strength - 5000 psi minimum

5) Water Absorption (ASTM D570; Section 6.5) at 14 days

a) Water Absorption - 1 percent maximum

6) Bond Strength (ASTM C882) Hardened to Plastic

a) Bond Strength (14 days moist cure) - 1500 psi minimum

7) Effective Shrinkage (ASTM C883)

a) Effective Shrinkage - Passes Test

* All test data is based upon material and curing conditions of 73 plus or minus 2 degrees F, 50 plus or minus 5 percent Relative Humidity

3. Approval Requirements

a. Furnish notarized certification that the material proposed for use, meets all of the above requirements.

b. Bonding agent shall be Sikastix 370, Sikadur Hi-Mod, by Sika Corporation, Lyndhurst, NJ or equal.

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B. Repair Mortar

1. General

a. Repair mortar shall be a two-component, polymer-modified, cementitious, fast setting, trowel grade, structural repair mortar suitable for use on horizontal, vertical and overhead surfaces, on grade above and below grade on concrete and mortar.

2. Material

a. The polymer modified cementitious system shall consist of a factory pre-proportioned two-component system whose components conform to the following requirements:

1) Component A shall be a liquid polymer emulsion of an acrylic copolymer base and additives. This acrylic copolymer shall have the following properties:

a) pH 4.5 to 6.5

b) Minimum film forming temperature approximately 68 degrees F

c) Tear Strength approximately 990 to 1420 psi

d) Elongation at break 500 to 900 percent

e) Particle Size Range Less than 0.1 micron

2) Component B shall be a blend of selected Portland cements, specially graded aggregates, organic accelerator and admixtures for controlling setting time, water reducers for workability and a corrosion inhibitor.

3) The component ratio A:B shall be 1:7.2 by weight. The system shall not contain chlorides, nitrates, added gypsum, added lime, or high alumina cements. The system shall be non-combustible, either before or after cure.

b. Typical Properties of Mixed Components

1) Application Time (Working Time) - 15 minutes after combining components

2) Finishing Time - 20 to 60 minutes after combining components

3) Color - Concrete Gray

c. Typical Properties of Cured Material

1) Abrasion Resistance - 6 times that of controlled concrete

2) Bond Strength (pull off method) - 100 percent concrete substrate failure

3) Modulus of Elasticity - 4,500,000 psi minimum

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4) Surface Scaling (Deicing salt solution freeze/thaw) - No deterioration after 120 cycles

5) Compressive Strength (2 hours 50 percent RH) - 150 psi minimum

6) Compressive Strength (28 days 50 percent RH) - 5,550 psi minimum

7) Flexural Strength (28 days 50 percent RH) - 1,300 psi minimum

8) This system shall conform to ECA/USPHS Standards for surface contact with potable water.

9) This system shall not produce a vapor barrier.

10) This system shall be thoroughly compatible with concrete.

11) Stone may be added.

12) System may be finished with power trowel.

d. Approval Requirements

1) Furnish notarized certification that the material proposed for use meets all of the above requirements.

2) Repair mortar shall be SikaTop 122 by Sika Corporation, Lyndhurst, NJ or equal.

C. Crack Sealant

1. General

a. Crack sealant shall be a two-component, solvent-free, moisture insensitive epoxy resin material suitable for crack grouting, by injection or gravity feed and bolt grouting and as a binder for mortar, concrete or grout in thermally stable environments and as a concrete sealer.

2. Material

a. The epoxy material shall conform to the following requirements:

1) Component A - Component A shall be a modified epoxy resin of the epichlorohydrin bisphenol A type, containing suitable viscosity control agents. It shall not contain butyl glycidyl ether.

2) Component B - Component B shall be primarily a reaction product of a selected amine blend with an epoxy resin of the epichlorohydrin bisphenol A type containing suitable viscosity control agents and accelerators.

3) The ratio of Components B:A shall be 1:2 by volume.

4) The material shall not contain asbestos.

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b. Properties of the mixed components*

1) Pot Life - 20 to 30 minutes

2) Tack free time to touch (3 to 5 mils) - 2 to 4 hours

3) Initial Viscosity (Brookfield Viscometer Spindle No. 2, Speed 100) - 300 to 450 cps

4) Color - Amber

c. Properties of the cured material*

1) Compressive Properties (ASTM D695) at 28 days

a) Compressive Strength - 10,500 psi minimum

b) Modulus of Elasticity - 300,000 psi minimum

2) Tensile Properties (ASTM D638) at 14 days

a) Tensile Strength - 5500 psi minimum

b) Elongation at Break - 2 to 5 percent

c) Modulus of Elasticity - 60,000 psi minimum

3) Flexural Properties (ASTM D790) at 14 days

a) Flexural Strength (Modulus of Rupture) - 12,500 psi minimum

b) Tangent Modulus of Elasticity in Bending - 325,000 psi minimum

4) Shear Strength (ASTM D732) at 14 days

a) Shear Strength - 4500 psi minimum

5) Water Absorption (ASTM D570; Section 6.5) at 7 days

a) Water Absorption - 1.5 percent maximum

6) Bond Strength (ASTM C882)

a) Bond Strength (2 days dry) - 2000 psi minimum

b) Bond Strength (2 days dry plus 12 days moist) - 2000 psi minimum

7) Effective Shrinkage (ASTM C883)

a) Effective Shrinkage - Passes Test

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8) When tested following the procedure prescribed by the Environmental Control Administration of the U.S. Public Health Service, the cured material shall be in conformity with the Federal Regulation requiring water extractables of less than 0.5 mg/in 2 of exposed surface for potable water containers.

* All test data is based upon material and curing conditions of 73 plus or minus 2 degrees F, 50 plus or minus 5 percent R.H.

3. Approval Requirements

a. Furnish notarized certification that the material proposed for use meets all of the above requirements.

b. Crack sealant shall be Sikastix 350, Sikadur Hi-Mod LV, by Sika Corporation, Lyndhurst, NJ or equal.

D. Epoxy Paste Adhesive

1. General

a. Epoxy paste adhesive shall be a two-component, solvent-free, moisture insensitive epoxy resin material suitable for bolt grouting, as an adhesive for mating surfaces where the glue line is 1/8-in. or less and to bond fresh, plastic concrete to clean, sound, hardened concrete.

b. The material shall be classified as Type I, Grade 3, Class B and C and a Type II, Grade 3, Class B and C adhesive in conformity to ASTM C881.

2. Material

a. The epoxy material shall conform to the following requirements:

1) Component A - Component A shall be a modified epoxy resin of the epichlorohydrin bisphenol A type, containing suitable viscosity control agents and pigments. It shall not contain butyl glycidyl ether.

2) Component B - Component B shall be primarily a reaction product of a selected amine blend with an epoxy resin of the epichlorohydric bisphenol A type containing suitable viscosity control agents, pigments and accelerators.

3) The ratio of Component B:A shall be 1:2 by volume.

4) The material shall not contain asbestos.

b. Properties of the mixed material*

1) Pot Life - 25 to 45 minutes

2) Tack-Free-Time to Touch - 2 to 3 hours

3) Consistency (1/2-in. thick) - Non-Sag

4) Color – Gray

c. Properties of the cured material*

1) Compressive Properties (ASTM D695) at 28 days

a) Compressive Strength, psi - 10,000 minimum

b) Modulus of Elasticity, psi - 700,000 minimum

2) Tensile Properties (ASTM D638) at 14 days

a) Tensile Strength, psi - 3000 minimum

b) Elongation at Break, percent - 0.3 minimum

c) Modulus of Elasticity, psi - 630,000 minimum

3) Flexural Properties (ASTM D790) at 14 days

a) Flexural Strength (Modulus of Rupture), psi - 3700 minimum

b) Tangent Modulus of Elasticity in Bending, psi - 850,000 minimum

4) Shear Strength (ASTM D732) at 14 days

a) Shear Strength, psi - 2800 minimum

5) Water Absorption (ASTM D570; Section 6.5) at 7 days

a) Water Absorption, percent - 1.0 maximum

6) When tested following the procedure prescribed by the Environmental Control Administration of the U.S. Public Health Service, the cured material shall be in conformity with the Federal Regulation requiring water extractables of less than 18 mg/sq in of exposed surface for potable water containers.

* All test data is based upon material and curing condition of 73 plus/minus 2 degrees F; 50 plus/minus 5 percent Relative Humidity

3. Approval Requirements

a. Furnish notarized certification that the material proposed for use meets all of the above requirements.

b. Epoxy paste adhesive shall be Sikastix 390, Sikadur 31 Hi-Mod Gel, by Sika Corporation, Lyndhurst, NJ or equal.

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E. Special Joint Sealant

1. Sealant shall be foamed polyurethane strip saturated with polybutylene waterproofing material. Sealant shall be applied to joint in a pre-compressed state.

2. When compressed to 50 percent of its original volume, sealant shall produce a hydrostatic seal.

3. Sealant shall maintain its resiliency to temperatures as low as minus 40 degrees F. Sealant shall be waterproof (when compressed to 50 percent of its original volume) in temperatures from minus 40 degrees F to plus 200 degrees F.

4. Elongation shall be at least 325 percent with a tensile strength of not less than 53 psi. The polybutylene compound in the polyurethane strip shall not migrate.

F. Metal primer shall be an approved organic zinc rich primer containing 95 percent zinc dust by weight.

G. Non-shrink Grout

1. Non-shrink grout for setting new anchor bolts in existing concrete shall be ready-to-use formulation, which when mixed with specific amounts of water will provide a pourable cementitious mixture.

2. Non-shrink grout for setting new anchor bolts shall be Super POR-ROK by CGM, Inc., or equal.

H. Adhesive Anchor System

1. Provide an adhesive anchor system utilizing an injection adhesive manufactured for the installation of drilled-in reinforcing steel dowels where indicated on the Drawings.

2. Injection Adhesive

a. Injection adhesive shall be a two-component epoxy system including a hardener and a resin, furnished in pre-measured side-by-side cartridges which keep the two components separate. Side-by-side cartridges shall be designed to accept a static mixing nozzle which thoroughly blends the two components and allows injection directly into the drilled hole.

3. Adhesive anchor system shall be Hilti RE 500 SD Adhesive Anchor System; Simpson Strong-Tie Epoxy SET-XP Adhesive Anchor System; Redhead G5 Adhesive Anchor System; or equal.

## PART 3 EXECUTION

### 3.01 GENERAL

A. Concrete removal, repairs and fabrication shall be as shown on the Drawings and as specified herein.

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B. Except as otherwise indicated, in all locations where new concrete is to be deposited against existing concrete, bonding compound shall be applied to the surfaces of the existing concrete prior to placement of new concrete.

C. In all cases where the joint between new concrete and existing concrete will be exposed in the finished work, except as otherwise shown or specified, the limit of concrete removal shall be defined by a 1-1/2-in. deep saw cut on each exposed surface of the existing concrete.

D. When the finished surface is not specified to be coated, the color of new concrete in the exposed surfaces shall match the color of the existing adjoining concrete as closely as possible.

E. Where indicated or specified, existing concrete shall be removed to the depth indicated or required to expose sound concrete. The surface exposed shall be roughened by chipping, sandblasting, scarifying or other appropriate means before applying bonding compounds, or repair material as specified.

F. The Engineer may from time to time direct the Contractor to make repairs to existing concrete. These repairs shall be made as specified herein or by such other methods as may be appropriate.

G. Reinforcing in existing concrete which is exposed as a result of removal of deteriorated concrete shall be wire brushed to remove all loose material and products of corrosion before proceeding with the repair.

H. All commercial products specified in this Section shall be stored, mixed and applied in strict accordance with the manufacturer's recommendations.

I. In all cases where concrete is repaired in the vicinity of an expansion joint or isolation joint the repairs shall be made so as to preserve the isolation between components on either side of the joint.

J. Where exposed embedded metal is required to be painted, prepare substrate as approved and paint with two coats zinc rich primer before installation of adjacent new materials.

3.02 SURFACE REPAIR AND PATCHING

A. Remove fractured, loose, deteriorated and unsound concrete by saw cutting, bush hammering, chipping or other appropriate means. Restore area to original limits or as shown using repair mortar.

3.03 EXPANSION JOINT REPAIR

A. Where indicated, existing pre-molded joint filler shall be removed and replaced with pre-molded joint filler as specified in Section 03250. Special joint sealant shall be installed as indicated in accordance with manufacturer's instructions.

3.04 CRACK REPAIR

A. Cracks on horizontal surfaces shall be repaired by gravity feeding crack sealant into cracks.

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B. Cracks on vertical surfaces shall be repaired by pressure injecting crack sealant through polyethylene valves sealed to surface with epoxy paste adhesive.

3.05 CONNECTION SURFACE PREPARATION

A. Connection surfaces shall be prepared as specified below for concrete areas requiring patching, repairs or modifications as shown on the Drawings, specified, or as directed by the Engineer.

B. The following are specific concrete surface preparation "methods" to be used where called for on the Drawings, specified or as directed by the Engineer.

1. Method A - After the existing concrete surface at connection has been roughened and cleaned, thoroughly saturate with water and maintain saturation for a period of at least 12 hours. Brush on a 1/16-in. layer of cement and water mixed to the consistency of a heavy paste. Immediately after application of cement paste, place new concrete or grout mixture as indicated.

2. Method B - After the existing concrete surface has been roughened and cleaned, apply epoxy bonding agent at connection surface. The field preparation and application of the epoxy bonding agent shall comply strictly with the manufacturer's recommendations. Place new concrete or grout mixture as indicated within time constraints recommended by the manufacturer to ensure bond.

3. Method C – Adhesive anchor system shall be used for all drilled-in reinforcing steel dowels. The installation shall comply strictly with manufacturer's recommendations, including drill bit diameter, surface preparation, temperature, moisture conditions, injection and installation of dowel. Use oil free compressed air to blast out loose particles and dust from the drilled holes. Dowels must be clean and free of dirt, oil, grease, ice or other material which would reduce bond. Unless otherwise shown on the Drawings, deformed bars shall be drilled and embedded to a depth equal to or greater than the length required to develop the tensile strength of the bar per the manufacturer's recommendations, including spacing of bars and edge distance.

4. Method D - Combination of Method B and C.

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SECTION 03800

# CONCRETE ELECTRICAL RACEWAY ENCASEMENT

## PART 1: GENERAL

### 1.01 SCOPE OF WORK

A. Furnish all labor, materials, equipment and incidentals required and install concrete encasement around underground electrical raceways as shown on the Drawings and as specified herein.

### 1.02 RELATED WORK

A. Excavation, backfilling, fill and grading are included in Division 2.

B. Concrete formwork is included in Section 03100.

C. Concrete joints and joint accessories are included in Section 03250.

D. Cast in place concrete is included in Section 03300.

E. Modifications to existing concrete are included in Section 03740.

F. Furnishing and installing electrical conduit is included in Division 16.

G. Furnishing and placing polyethylene warning tape in the backfill above encasement is included in Division 16.

## PART 2: PRODUCTS

### 2.01 MATERIALS

A. Cement, lime, aggregate and all other concrete components shall be as specified in Section 03300 except that aggregate size shall not exceed 3/8-inch. Concrete shall have a minimum compressive strength at 28 days of 2500 psi.

## PART 3: EXECUTION

### 3.01 GENERAL

A. Concrete shall conform to the requirements Section 03300 and as specified herein.

B. Provide not less than 4 inches of concrete between the outside of a raceway and the earth. Provide not less than 2 inches of concrete between adjacent raceways. Form as specified in Section 03100 for buried concrete.

C. All raceway concrete placements shall be continuous between manholes or handholes and between manholes or handholes and structures.

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D. Where raceways pass through concrete walls, concrete encasement shall be extended through the finished flush with inside surfaces. Watertight construction joints with waterstops conforming to Section 03250 shall be provided.

E. Encasements shall be reinforced as and where indicated on the Drawings.

F. Encasements shall be laid in trenches on mats of screened gravel not less than 6-inch-thick.

G. The minimum cover for raceway banks shall be 24-inch.

END OF SECTION

# DIVISION 5

# METALS

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SECTION 05500

MISCELLANEOUS METALS

PART 1: GENERAL

1.01 SCOPE OF WORK

A. Furnish all labor, materials, equipment and incidentals required and install all miscellaneous metal complete as shown on the Drawings and as specified herein.

1.02 RELATED WORK

A. Concrete joint accessories are included in Section 03250.

B. Painting is included in Division 9.

C. Sluice gates, slide gates, operators and appurtenances, including wall thimbles, are included in Division 11.

D. Pipe hangers and sleeves are included in Division 15.

E. Equipment anchor bolts are included in the respective Sections of Divisions 11, 14 and 15.

1.03 SUBMITTALS

A. Submit, in accordance with Section 01300, shop drawings and product data showing materials of construction and details of installation for:

1. Shop drawings, showing sizes of members, method of assembly, anchorage and connection to other members.

B. Samples

1. Submit samples as requested by the Engineer during the course of construction.

C. Design Data

1. Submit calculations or test data demonstrating that the railings will resist the loads specified in the International Building Code 2006 at the post spacing provided. Calculations shall be stamped by a professional engineer licensed in the state of Arkansas.

2. Submit manufacturer's load and deflection tables for grating.

D. Test Reports

1. Certified copy of mill test reports on each steel, stainless steel, and aluminum proposed for use showing the physical properties and chemical analysis.

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E. Certificates

1. Submit certification that the railing system is in compliance with OSHA requirements the International Building Code 2006.

2. Certify that welders have been qualified under AWS, within the previous 12 months, to perform the welds required under this Section.

1.04 REFERENCE STANDARDS

A. Aluminum Association (AA)

1. AA M31C22A41

a. M31: Mechanical Finish, Fine Satin

b. C22: Finish, Medium Matte

c. A41: Clear Anodic Coating, Class I

B. American Society for Testing and Materials (ASTM)

1. ASTM A36 - Standard Specification for Carbon Structural Steel.

2. ASTM A48 - Standard Specification for Gray Iron Castings.

3. ASTM A53 - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.

4. ASTM A108 - Standard Specification for Steel Bars, Carbon, Cold Finished, Standard Quality.

5. ASTM A123 - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.

6. ASTM A153 - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.

7. ASTM A240 - Standard Specification for Heat-Resisting Chromium and Chromium-Nickel Stainless Plate, Sheet, and Strip Pressure Vessels.

8. ASTM A276 - Standard Specification for Stainless Steel Bars and Shapes.

9. ASTM A307 - Standard Specification for Carbon Steel Bolts and Studs, 60,000 Psi Tensile Strength.

10. ASTM A325 - Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength.

11. ASTM A500 - Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.

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12. ASTM A501 - Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing.

13. ASTM A536 - Standard Specification for Ductile Iron Castings.

14. ASTM A570 - Standard Specification for Steel, Sheet and Strip, Carbon, Hot-Rolled, Structural Quality.

15. ASTM A1008 - Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable.

16. ASTM B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.

17. ASTM B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles and Tubes.

18. ASTM B429 - Standard Specification for Aluminum-Alloy Extruded Structural Pipe and Tube.

19. ASTM F1554 -Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength.

20. ASTM F2329 - Specification for Zinc Coating, Hot-Dip, Requirements for Application to Carbon Screws, Washers, Nuts, and Special Threaded Fasteners.

C. American Institute of Steel Construction (AISC)

1. Specification for Structural Steel Buildings – Allowable Stress Design and Plastic Design.

D. American Welding Society (AWS)

1. AWS D1.1 - Structural Welding Code - Steel.

2. AWS D1.2 - Structural Welding Code - Aluminum.

3. AWS D1.6 - Structural Welding Code - Stainless Steel.

E. Federal Specifications

1. FS-FF-B-575C - Bolts, Hexagonal and Square

F. Occupational Safety and Health Administration (OSHA)

G. International Code Council

1. International Building Code 2006

H. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.05 QUALITY ASSURANCE

A. The work of this Section shall be completely coordinated with the work of other Sections. Verify, at the site, both the dimensions and work of other trades adjoining items of work in this Section before fabrication and installation of items herein specified.

B. Furnish to the pertinent trades all items included under this Section that are to be built into the work of other Sections.

C. All welding shall be performed by qualified welders and shall conform to the applicable AWS welding code. Welding of steel shall conform to AWS D1.1 and welding of aluminum shall conform to AWS D1.2 and welding of stainless steel shall conform to AWS D1.6.

1.06 DELIVERY, STORAGE AND HANDLING

A. Deliver items to be incorporated into the work of other trades in sufficient time to be checked prior to installation.

B. Store materials on skids and not on the ground and block up so that they will not become bent or otherwise damaged. Handle materials with cranes or derricks. Do not dump material off cars or trucks nor handle in any other way that will cause damage.

C. Repair items that have become damage or corroded to the satisfaction of the Engineer prior to incorporating them into the work.

1.07 PROJECT/SITE REQUIREMENTS

A. Field measurements shall be taken at the site, prior to fabrication of items, to verify or supplement indicated dimensions and to ensure proper fitting of all items.

PART 2: PRODUCTS

2.01 GENERAL

A. The use of manufacturer's name and model or catalog number is for the purpose of establishing the standard of quality and general configuration desired.

B. Like items of materials shall be the end products of one manufacturer in order to provide standardization for appearance, maintenance and manufacturer's service.

2.02 MATERIALS

A. Unless otherwise noted, materials for miscellaneous metals shall conform to the following standards:

| | |
|---|---|
| 1. Structural Steel | Wide flange shapes: ASTM A992<br>Other shapes; plates; rods and bars: ASTM A36 |
| 2. Structural Steel Tubing | ASTM A500, Grade B |

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| | |
|---|---|
| 3. Welded and Seamless Steel Pipe | ASTM A501 or ASTM A53, Type E or S, Grade B Schedule 40. Use standard malleable iron fittings, galvanized for exterior work |
| 4. Steel Sheets | ASTM A1008 |
| 5. Gray Iron Castings | ASTM A48, Class 35 |
| 6. Ductile Iron Castings | ASTM A536, Grade 65-45-12 |
| 7. Aluminum Extruded Pip | ASTM B429, Alloy 6063 T6 and Alloy 6061 T6 as indicated |
| 8. Aluminum Extruded Shapes | ASTM B221, Alloy 6061 T6 |
| 9. Aluminum Sheet and Plate | ASTM B209, Alloy 6061 T6 |
| 10. Stainless Steel Plates, Sheets, and Structural Shapes | |
| a. Exterior, Submerged or Industrial Use | ASTM A240, Type 316 (Type 316L for welded) |
| b. Interior and Architectural Use | ASTM A240, Type 304 |
| 11. Stainless Steel Bolts, Nuts, and Washers | ASTM A276, Type 316 |
| 12. Carbon Steel Bolts and Studs | ASTM A307, Grade A (hot dip galvanized nuts and washers where noted) |
| 13. High Strength Steel Bolts, Nuts and washers | ASTM A325 (mechanically galvanized per ASTM B695, Class 50, where noted) |
| a. Elevated Temperature Exposure | Type I |
| b. General Application | Type I or Type II |
| 14. Galvanizing | ASTM A123, Zn w/0.05 percent minimum Ni |
| 15. Galvanizing, hardware | ASTM A153, Zn w/0.05 percent minimum Ni |
| 16. Galvanizing, anchor bolts | ASTM F2329, Zn w/0.05 percent minimum Ni |
| 17. Welding electrodes, steel | AWS A5.1 E70xx |

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2.03 ANCHORS, BOLTS AND FASTENING DEVICES

A. Unless otherwise noted, anchor bolts shall be ASTM F1554, Grade 36. Provide standard headed bolts with heavy hex nuts and Grade A washers. Where galvanized anchor bolts are shown or specified, provide standard headed bolts with heavy hex nuts and Grade A washers, all galvanized in accordance with ASTM F2329.

B. Unless otherwise noted, bolts for the connection of carbon steel or iron shall be steel machine bolts; bolts for the connection of galvanized steel or iron shall be galvanized steel or stainless steel machine bolts; and bolts for the connection of aluminum or stainless steel shall be stainless steel machine bolts.

C. Unless otherwise noted, expansion anchors shall be zinc plated carbon steel wedge type anchors complete with nuts and washers. Type 316 stainless steel wedge type anchors shall be used where they will be submerged or exposed to the weather or where stainless steel wedge type anchors are shown or specified. When the length or embedment of the bolt is not noted on the Drawings, provide length sufficient to place the wedge and expansion cone portion of the bolt at least 1 inch behind the concrete reinforcing steel. Expansion anchors shall be Hilti, Kwik-Bolt III; Simpson Strong-Tie Wedge-All; Powers Power-Stud or equal.

D. Adhesive anchor system, for fastening to solid concrete substrate, shall be a system manufactured for the installation of post installed studs including anchoring hardware and chemical dispenser. Injection adhesive shall be a two-component epoxy system including a hardener and a resin, furnished in pre-measured side-by-side cartridges which keep the two components separate. Side-by-side cartridges shall be designed to accept a static mixing nozzle which thoroughly blends the two components and allows injection directly into the drilled hole. Provide zinc plated carbon steel or Type 316 stainless steel stud assemblies as indicated on the Drawings consisting of an all-thread anchor rod with nut and washer. Adhesive anchor system shall be Hilti RE 500 SD; Simpson Strong Tie SET-XP; ITW Ramset Red Head Epcon G5; or equal. Unless otherwise noted, anchorage designs shown on the Drawings are based on Hilti RE 500 SD.

E. Adhesive anchors, for fastening to hollow concrete block or brick, or hollow-core precast concrete planks shall be a three-part stud, screen tube and chemical dispenser anchoring system. Adhesive cartridges shall contain pre-measured amounts of resin and hardener which are mixed and deposited in a screen tube by a dispenser. Provide zinc plated carbon steel or Type 316 stainless steel stud assemblies as indicated on the Drawings consisting of an all-thread anchor rod with nut and washer. Anchors shall be Hilti HIT HY-70 System; Rawlplug Company Chem-Fast; ITW Ramset Redhead Ceramic 6 Epcon System, or equal.

F. Automatic end welded headed anchor studs shall be flux ended studs made from cold drawn steel, ASTM A108 Grades C-1010 through C-1020. Headed anchor studs shall be Nelson, S3L Shear Connectors or equal.

G. Machine bolts and nuts shall conform to Federal Specification FF-B-575C. Bolts and nuts shall be hexagon type. Bolts, nuts, screws, washers and related appurtenances shall be Type 316 stainless steel.

H. Toggle bolts shall be Hilti, Toggler Bolt or equal.

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2.04 RAILINGS

A. Handrail and guardrail systems shall comply with the requirements of OSHA and IBC.

B. Aluminum railing and handrail shall be a welded or mechanically fastened, seamless, extruded aluminum pipe system. Rails shall be 6063-T6 alloy. Posts shall be 6061-T6 alloy. Splice and reinforcing sleeves, brackets, end caps, toe boards, etc., shall be aluminum alloy 6063-T6 or 6061-T6. Cast fittings shall be aluminum alloy No. 214. Railing system fastening hardware shall be Type 316 stainless steel. Aluminum shall have a mill finish. After welding, aluminum shall be anodized. All railing, posts, toe boards and exposed aluminum shall be anodized with an architectural Class I satin finish providing a minimum coating thickness of 0.7 mils and a minimum coating weight of 32 milligrams per square inch in compliance with AA M12C22A41.

C. Railings shall be 2-rail welded railing systems, as shown on the Drawings, fabricated with 1-1/2-inch nominal diameter pipe. Posts shall be Schedule 80 pipe, minimum and rails and handrail shall be Schedule 40 pipe, minimum. Posts and top rails shall be continuous. Spacing of posts shall not exceed 5-ft on center and shall be uniformly spaced except as otherwise shown on the Drawings. All railing posts shall be vertical.

D. Welds shall be circumferential welds ground smooth and even to produce a railing that is neat in appearance and structurally sound. Welding methods shall be in conformity with AWS standards for the materials being joined. For welding aluminum, use a weld filler alloy that is compatible with the alloys to be joined, that will not discolor the pieces to be joined and that will not be discolored by anodizing. All rails to post connections shall be coped and fastened by continuous welds. There shall be no burrs, sharp edges or protrusions on any weld on any part of the handrail system. After fabrication, the welds and surrounding area shall be cleaned and hand buffed to blend with the adjacent finish. All mechanical fasteners shall be unobtrusively located in countersunk holes with the top flush with the surface of the rail. Bends in the railing shall be as indicated by the Drawings. No distortion of the circular railing shape will be allowed. Bends and terminal sections shall be made without the use of fittings. Corner bends shall have a 3-inch centerline radius.

E. Railing shall be assembled in sections as long as practical but shall not be greater than 24 ft in length. A field splice shall be used when an assembled section is to be attached to another section. Field splices shall be used in all railing panels that cross over structure expansion joints.

1. Field splices shall use internal splice sleeves located within 8 inches of railing posts. The sleeve shall be welded to the rail on one side and fastened with a set screw to the rail on other side. The field splice shall be detailed to take the differential expansion between the railing system and the supporting structure.

2. When the field splice occurs in a railing panel crossing a structure expansion joint, the sleeve shall be welded to the rail on one side and be free to slide in the rail on other side. The field splice shall be detailed to take the same movement as the structure expansion joint.

F. The bases or supports for railing posts and handrail shall be the types indicated on the Drawings.

1. Where non-removable railing is set in concrete, the posts shall be placed in 2-1/2-inch diameter formed concrete openings and firmly caulked with cement grout. Collars shall be placed around the post bases and fastened in place with set screws on the side of the post away from the walkway. Posts shall be placed with the centerline 4 inches from the edge of the concrete except that posts shall be set at the centerline of concrete curbs.

2. Stainless steel and aluminum railing posts, which may collect condensation, shall have a 3/16-inch drain hole drilled immediately above the concrete encased area, the base flange, or supporting socket on the side away from the walking area. The bottom of the rail post between the drain hole and the bottom of the post shall be filled with an inert material such as a compressed closed cell neoprene rod.

3. Where handrail is to be fastened to walls, the rails shall be provided with screwed wall flanges fastened to the walls with three 3/8-inch stainless steel flat head machine screws. The horizontal projection of the handrail support off the wall shall provide 2-1/2-inch minimum clearance below the bottom of the handrail.

G. Safety gates, for railing openings, shall be fabricated of matching pipe and rail material and configuration. The gates shall be self-closing gates with approved stop, latch and stainless steel closure spring and hinges.

H. Barrier chains, for railing openings, shall be fabricated of stainless steel chains. Chain shall be 1/4-inch stainless steel links, with eleven links per foot as manufactured by Eastern Chain Works, Inc., NY; Lawrence Metal Products, Inc. or equal. Chains shall be fastened to the handrail posts at the elevation of each rail. One end of each chain shall be connected to one post with a 1/4-inch diameter stainless steel eye bolt and the other end shall be connected to the other post by means of a heavy chromium plated bronze swivel eye slide harness snap and a similar eye bolt.

I. Toe boards shall be provided on all railing adjacent to a drop in elevation of 4 ft or more. Toe boards are not required on the inclined portion of stairway railings or where concrete or steel curbs, 4 inches or more in height, are present. Toe boards shall be 4-inch-high channels of the same material as the railing. The channels shall have a minimum thickness of 1/8 inch and have flanges of not less than 3/4 inch, nor more than 1-1/2-inches in width. Toe boards shall be positioned with a maximum clearance of 1/4 inch from the floor and fastened to railing posts with 1/4-inch stainless steel U-bolts, with J-bolts at corner posts and with clip angles and two 1/4-inch stainless steel expansion bolts at walls.

J. All railings shall be properly protected by paper, or by an approved coating or by both against scratching, splashes or mortar, paint, or other defacements during transportation and erection and until adjacent work by other trades has been completed. After protective materials are removed, the surfaces shall be made clean and free from stains, marks, or defects of any kind.

## 2.05 ACCESS HATCHES

A. Access hatches shall have single or double leaf doors as indicated by the Drawings. The doors shall be 1/4-inch aluminum diamond pattern plate with welded stiffeners, as necessary, to withstand a live load of 300 lbs/sq ft with a maximum deflection of 1/150th of the span.

Hatches shall have a 1/4-inch aluminum channel frame with a perimeter anchor flange or strap anchors for concrete embedment around the perimeter. Unless otherwise noted on the Drawings, use pivot torsion bars for counterbalance or spring operators for easy operation along with automatic door hold open. Hardware shall be durable and corrosion resistant with Type 316 stainless steel hardware used throughout. Provide removable lock handle. Finish shall be the factory mill finish for aluminum doors and frames with bituminous coating on the exterior of the frames in contact with concrete. Access hatches shall be aluminum by Bilco Company, New Haven, CT or equal.

## 2.06 MISCELLANEOUS ALUMINUM

A. All miscellaneous metal work shall be formed true to detail, with clean, straight, sharply defined profiles and smooth surfaces of uniform color and texture and free from defects impairing strength or durability. Holes shall be drilled or punched. Edges shall be smooth and without burrs. Fabricate supplementary pieces necessary to complete each item though such pieces are not definitely shown or specified.

B. Connections and accessories shall be of sufficient strength to safely withstand the stresses and strains to which they will be subjected. Exposed joints shall be close fitting and jointed where least conspicuous. Threaded connections shall have the threads concealed where practical. Welded connections shall have continuous welds or intermittent welds as specified or shown. The face of welds shall be dressed flush and smooth. Welding shall be on the unexposed side as much as possible in order to prevent pitting or discoloration of the aluminum exposed surface. Grind smooth continuous welds that will be exposed. Provide holes for temporary field connections and for attachment of the work of other trades.

C. Miscellaneous aluminum items shall include: beams, angles, closure angles, grates, hatches, floor plates, stop plates, stair nosings and any other miscellaneous aluminum called for on the Drawings and not otherwise specified.

D. Angle frames for hatches, beams, grates, etc., shall be complete with welded strap anchors attached.

E. Aluminum diamond plate and floor plate shall have a minimum thickness of 3/8 inch. Frames and supports shall be of aluminum construction. Fastening devices and hardware shall be Type 316 stainless steel. Plates shall have a mill finish.

F. Stair treads for aluminum stairs shall have abrasive non-slip nosing as approved.

G. Aluminum nosing at concrete stairs shall be Wooster Products, Inc.; Alumogrit Treads, Type 116; similar by Barry Pattern and Foundry Co.; Andco or equal. Furnish with wing type anchors and flat head stainless steel machine screws, 12 inches on center. Nosing shall also be used at concrete ladder openings. Nosing shall a single piece for each step extending to within 3-in. at each side of stair or full ladder width. Set nosing flush with stair tread finish at concrete stairs. Furnish treads with heavy duty protective tape cover.

## 2.07 MISCELLANEOUS STEEL

A. All miscellaneous metal work shall be formed true to detail, with clean, straight, sharply defined profiles and smooth surfaces of uniform color and texture and free from defects impairing strength or durability. Holes shall be drilled or punched. Edges shall be smooth and

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without burrs. Fabricate supplementary pieces necessary to complete each item though such pieces are not definitely shown or specified.

B. Connections and accessories shall be of sufficient strength to safely withstand the stresses and strains to which they will be subjected. Exposed joints shall be close fitting and jointed where least conspicuous. Threaded connections shall have the threads concealed where practical. Welded connections shall have continuous welds or intermittent welds as specified or shown. The face of welds shall be dressed flush and smooth. Grind smooth continuous welds that will be exposed. Provide holes for temporary field connections and for attachment of the work of other trades.

C. Miscellaneous steel items shall include: beams, angles, lintels, metal stairs, support brackets, base plates for other than structural steel or equipment, closure angles, bridge crane rails, monorail hoist beams, hold-down straps and lugs, door frames, splice plates, sub-framing at roof openings and any other miscellaneous steel called for on the Drawings and not otherwise specified.

D. Structural steel angle and channel door frames shall be galvanized. Frames shall be fabricated with not less than three anchors on each jamb.

E. Steel pipe pieces for sleeves, lifting attachments and other functions shall be Schedule 40 pipe unless otherwise shown on the Drawings. Wall and floor sleeves, of steel pipe, shall have welded circumferential steel waterstops at mid-length.

F. All steel finish work shall be thoroughly cleaned, by effective means, of all loose mill scale, rust and foreign matter and shall be given one shop coat of primer compatible with the finish coat after fabrication but before shipment. Paint shall be omitted within 3-in. of proposed field welds. Paint shall be applied to dry surfaces and shall be thoroughly and evenly spread and well worked into joints and other open spaces.

G. Galvanizing, where required, shall be the hot-dip zinc process after fabrication. Coating shall be not less than 2 oz/sq ft of surface.

## 2.08 MISCELLANEOUS STAINLESS STEEL

A. All miscellaneous metal work shall be formed true to detail, with clean, straight, sharply defined profiles and smooth surfaces of uniform color and texture and free from defects impairing strength or durability. Holes shall be drilled or punched. Edges shall be smooth and without burrs. Fabricate supplementary pieces necessary to complete each item though such pieces are not definitely shown or specified.

B. Connections and accessories shall be of sufficient strength to safely withstand the stresses and strains to which they will be subjected. Exposed joints shall be close fitting and jointed where least conspicuous. Threaded connections shall have the threads concealed where practical. Welded connections shall have continuous welds or intermittent welds as specified or shown. The face of welds shall be dressed flush and smooth. Grind smooth continuous welds that will be exposed. Provide holes for temporary field connections and for attachment of the work of other trades.

C. Miscellaneous stainless steel items shall include: beams, angles, bar racks and any other miscellaneous stainless steel called for on the Drawings and not otherwise specified.

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2.09 CASTINGS

A. Casting shall be of good quality, strong, tough, even-grained, smooth, free from scale, lumps, blisters, sand holes and defects of any kind which render them unfit for the service for which they are intended. Castings shall be thoroughly cleaned and will be subjected to a hammer inspection in the field by the Engineer. All matching surfaces shall be machined to a true plane surface to allow contact surfaces to seat at all points without rocking. Allowances shall be made in the patterns so that the thickness specified shall not be reduced in obtaining finished surfaces. Castings will not be acceptable if the actual weight is less than 95 percent of the theoretical weight computed from dimensions. The Contractor shall provide facilities for weighing castings in the presence of the Engineer.

B. Frames, covers, cast grates and trench drains for structures shall be gray iron castings except as otherwise specified or indicated on the Drawings. Sizes shall be as shown on the Drawings. Covers shall have letters "WATER," "SANITARY SEWER," or DRAIN," as applicable, embossed on top.

C. Frames and covers for installation in slabs shall be heavy duty, R-6013-R-6099 Series as manufactured by Neenah Foundry Co., or equal.

D. Electrical and telephone manhole and handhole frames and covers for structures shall be ductile iron castings. The covers shall be watertight. Covers shall have the word "ELECTRIC," "HIGH VOLTAGE," "LOW VOLTAGE," "SIGNAL," "TELEPHONE," as applicable, embossed on or cast into the top in letters 2-inch-high. The clear opening shall be 36-inch unless otherwise indicated on the Drawings.

E. Trench drains shall be of the length shown on the Drawings and shall be heavy duty, R-4990 Series with a "Type A" cover as manufactured by Neenah Foundry Co. or equal.

PART 3: EXECUTION

3.01 INSTALLATION

A. Install all items except those to be embedded in concrete or other masonry which shall be installed under Division 3 and Division 4 respectively. Items to be attached to concrete or masonry after such work is completed shall be installed in accordance with the details shown. Fastening to wood plugs in masonry will not be permitted.

B. Abrasions in the shop primer shall be touched up immediately after erection. Areas left unprimed for welding shall be painted with primer after welding.

C. Zinc coating which has been burned by welding, abraded, or otherwise damaged shall be cleaned and repaired after installation. The damage area shall be thoroughly cleaned by wire brushing and all traces of welding flux and loose or cracked zinc coating removed prior to painting. The cleaned area shall be painted with two coats of zinc oxide-zinc dust paint conforming to the requirements of Military Specifications MIL-P-15145. The paint shall be properly compounded with a suitable vehicle in the ratio of one part zinc oxide to four parts zinc dust by weight.

D. Specialty products shall be installed in accordance with the manufacturer's recommendations.

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E. Expansion bolts shall be checked for tightness a minimum of 24 hours after initial installation.

F. Install adhesive anchor system in strict compliance with the manufacturer's recommendations, including drill bit diameter, surface preparation, temperature, moisture conditions, injection and installation of bolts. Use oil free compressed air to blast out loose particles and dust from the drilled holes. Bolts must be clean and free of dirt, oil, grease, ice or other material which would reduce bond.

G. Headed anchor studs shall be welded in accordance with manufacturer's recommendations.

H. All railings shall be erected to line and plumb.

I. All steel surfaces that come into contact with exposed concrete or masonry shall receive a protective coating of an approved heavy bitumastic troweling mastic applied in accordance with the manufacturer's instructions prior to installation.

J. Where aluminum contacts a dissimilar metal, apply a heavy brush coat of zinc-chromate primer followed by two coats of aluminum metal and masonry paint to the dissimilar metal.

K. Where aluminum contacts masonry or concrete, apply a heavy coat of approved alkali resistant paint to the masonry or concrete.

L. Where aluminum contacts wood, apply two coats of aluminum metal and masonry paint to the wood.

M. Between aluminum gratings, aluminum stair treads, or aluminum handrail brackets and steel supports, insert 1/4-inch-thick neoprene isolator pads, 85 plus or minus 5 Shore A durometer, sized for full width and length of bracket or support.

END OF SECTION

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SECTION 05511

GRATED PLATFORMS, STAIRS, AND RAILING SYSTEMS

PART 1: GENERAL

1.01 SCOPE OF WORK

A. Furnish all labor, materials, equipment, and incidentals required for the design, fabrication and installation of elevated platforms, stairs, aluminum pipe handrail and guardrail systems, and platform/stair foundations as shown on the Drawings and as specified herein.

B. Provide the required systems:

1. Aluminum framing for elevated platforms, guardrails, grating, stairs, and grating treads and cast-in-place concrete for foundations as indicated on the Structural and Mechanical Drawings.

1.02 RELATED WORK

A. Cast-in-Place Concrete is included in Section 03300.

B. Miscellaneous Metals are included in Section 05500.

C. Metal Handrails and Guardrails in Section 05500.

D. Grating and Cover Plates in Section 05530.

E. Painting is included in Division 9.

1.03 SUBMITTALS

A. Submit to the Engineer, in accordance with Section 01300, shop drawings showing clearly the location, size and details of all members, including length and size of all shop and field welds. Each field piece shall be plainly marked with suitable erection marks which shall also be shown on the erection diagram. Shop drawings shall show erection details and welding conditions.

B. Furnish the Engineer a letter signed and sealed by a structural engineer licensed in the State of Arkansas that the platform/stair and railing system design conform to the design criteria set forth by the Engineer. Submit sealed and signed calculations with shop drawings.

C. Submit to the Engineer data showing the location, magnitude and direction of all dead and live load reactions imposed on the structure by the platform, stairs, and railing system.

1.04 REFERENCE STANDARDS

A. Aluminum Association (AA)

1. AA ADMI – Aluminum Design Manual, Parts I-A and II-A

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2. AA M31C22A41

   a. M31: Mechanical Finish, Fine Satin

   b. C22: Finish, Medium Matte

   c. A41: Clear Anodic Coating, Class I

B. American Society for Testing and Materials (ASTM)

   1. ASTM B209 – ASTM B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.

   2. ASTM B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles and Tubes.

   3. ASTM B429 - Standard Specification for Aluminum-Alloy Extruded Structural Pipe and Tube.

C. American Welding Society (AWS)

   1. AWS D1.2 - Structural Welding Code Aluminum.

D. National Association of Architectural Metal Manufacturers (NAAMM)

   1. NAAMM AMP-521 – Pipe Railing Manual.

E. Occupational Safety and Health Administration (OSHA)

F. International Building Code, 2006 edition

G. American Concrete Institute

   1. Building Code Requirements for Structural Concrete (ACI 318-05)

H. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.05 QUALITY ASSURANCE

A. The work of this Section shall be completely coordinated with the work of other Sections. Verify, at the site, both the dimensions and work of other trades adjoining items of work in this Section before fabrication and installation of items herein specified.

B. Furnish to the pertinent trades all items included under this Section that are to be built into the work of other Sections.

C. All welding shall be performed by qualified welders and shall conform to the applicable AWS welding code. Welding of aluminum shall conform to AWS D1.2.

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1.06 DELIVERY, STORAGE, AND HANDLING

A. Deliver items to be incorporated into the work of other trades in sufficient time to be checked prior to installation.

B. Repair items that have become damage or corroded to the satisfaction of the Engineer prior to incorporating them into the work.

C. Materials with excessive damage in the opinion of the Engineer shall not be incorporated in the work and shall be removed and replaced with new undamaged materials by the Contractor at no expense to the Owner.

PART 2: PRODUCTS

2.01 DESIGN CRITERIA

A. Prior to the Design of any structural member, the contractor and/or the elevated platform/stair manufacturer/supplier should verify all existing dimensions and conditions in addition to coordinating the final platform/stair dimensions with the Drawings and the approved adjacent Equipment Submittals.

B. Provide the elevated platforms and stairs which are capable of withstanding 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 component of elevated platform/stair.

1. Support Framing for Platforms and Stairs: Capable of withstanding a uniform live load of 100 lbs/sq. ft. in addition to stresses resulting from railing system.

2. Stair Treads: Capable of supporting uniform load of 100 lbs/sq. ft. or concentrated load of 300 psf on area of 4 square inches.

3. Limit live load deflection to L/360 and total load deflection to L/240 of span for all supporting members.

C. Spread footings for support of platforms or stair landings shall be designed for a maximum bearing pressure of 1250 psf.

D. For handrail and guardrail design criteria, refer to Section 05500.

2.02 MATERIALS

A. Aluminum Extruded Pipe, Shapes and Plate as specified in Section 05500.

B. Grating and Cover Plates as specified in Section 05530.

C. Anchors, Bolts and Fastening Devices are specified in Section 05500.

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2.03 FABRICATION

A. Prior to the Fabrication of any structural member, The contractor and/or the elevated platform/stair manufacturer/supplier should verify all existing dimensions and conditions in addition to coordinating the final elevated platform dimensions with the approved Equipment Submittals and the Drawings.

B. Size members as required by design calculations and to conform to layout details shown.

C. Fabricate stairs with aluminum stringer channels and aluminum grating treads with checkered plate nosing, as manufactured by IKG Industries, or approved equal.

D. Use aluminum gratings with minimum 1-¼-inch by 3/16-inch bearing bars and 4-ft-0-inch maximum span for all platforms. See Specification Section 05500 for additional requirements for grating.

E. Form work true to line and level with accurate angles and surfaces and straight sharp edges. Ease exposed edges to radius of approximately 1/32 inch. Form bent metal corners to smallest radius possible without causing grain separation or otherwise impairing work.

F. Connections and accessories shall be of sufficient strength to safely withstand the stresses and strains to which they will be subjected. Exposed joints shall be close fitting and jointed where least conspicuous. Threaded connections shall have the threads concealed where practical. Welded connections shall have continuous welds or intermittent welds as specified or shown. The face of welds shall be dressed flush and smooth. Welding shall be on the unexposed side as much as possible in order to prevent pitting or discoloration of the aluminum exposed surface. Grind smooth continuous welds that will be exposed. All welding shall be in accordance with AWS. Provide holes for temporary field connections and for attachment of the work of other trades.

G. All bolts for connecting aluminum to aluminum and aluminum to concrete shall be stainless steel.

H. All aluminum members shall have a cleaned and degreased mill finish.

PART 3: EXECUTION

3.01 EXAMINATION

A. Verify that field conditions are acceptable and are ready to receive work prior to commencing installation.

3.02 INSTALLATION

A. Install all items except those to be embedded in concrete or other masonry which shall be installed under Division 3 and Division 4 respectively. Items to be attached to concrete or masonry after such work is completed shall be installed in accordance with the details shown. Fastening to wood plugs in masonry will not be permitted.

B. Specialty products shall be installed in accordance with the manufacturer's recommendations.

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C. Expansion bolts shall be checked for tightness a minimum of 24 hours after initial installation.

D. Install adhesive anchors using manufacture's recommended drive units and adapters and in compliance with the manufacturer's recommendations. Tension capacity test data shall be provided at the request of the Owner.

E. Where aluminum contacts a dissimilar metal, apply a heavy brush coat of zinc-chromate primer followed by two coats of aluminum metal and masonry paint to the dissimilar metal.

F. Where aluminum contacts masonry or concrete, apply a heavy coat of approved alkali resistant paint to the masonry or concrete.

G. Where aluminum contacts wood, apply two coats of aluminum metal and masonry paint to the wood.

H. Between aluminum grating, aluminum stair treads, or aluminum handrail brackets and steel supports, insert 1/4-inch-thick neoprene isolator pads, 85 plus or minus 5 Shore A durometer, sized for full width and length of bracket or support.

I. Install railing systems and components as shown and in conformance with approved shop drawings.

3.03 ERECTION TOLERANCES

A. Guard rail posts shall have maximum ¼ inch variation from plumb.

3.04 PROTECTION AND CLEANING

A. Protect handrail systems and finishes against harmful substances and construction activities.

B. Remove protective coverings when directed. Clean stainless steel and aluminum surfaces with plain water, or water with soap or household detergent.

C. Clean, prepare abraded primed steel surfaces and touch up with the approved shop primer.

END OF SECTION

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SECTION 05515

ALUMINUM LADDERS AND ACCESSORIES

PART 1: GENERAL

1.01 SCOPE OF WORK

A. Furnish all labor, materials, equipment and incidentals required and provide complete ladders and accessories as shown on the Drawings and as specified herein.

1.02 RELATED WORK

A. Miscellaneous Metals are included in Section 05500.

1.03 SUBMITTALS

A. Submit, in accordance with Section 01300, manufacturer's shop drawings to indicate compliance with this Section. Show locations, methods of supporting, methods of anchoring and finishes.

1.04 REFERENCE STANDARDS

A. Occupational Safety and Health Administration (OSHA).

B. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

PART 2: PRODUCTS

2.01 FIXED WALL LADDERS

A. Fixed wall ladders and accessories shall comply with all requirements of OSHA, 29 CFR 1910.27.

B. Manufacturers:

1. Shop-fabricated from details on the Drawings

2. Precision Stair Corp.

   a. Model FL - (length as scheduled)

3. O'Keeffe's Inc. Model 520-CH (Standard)

4. Aluminex, Inc. Model 530-SC (Safety Cage)

   a. Model LC-100 (Standard)

   b. Model LC-300 (Safety Cage as detailed on the Drawings)

5. Or Equal.

C. Materials

1. Side Rails/Safety Cages. Aluminum plates, alloy 6061-T6 or aluminum extrusions, alloy 6063-T5. Where extensions are provided, the side rail shall be channel shapes having a wall thickness not less than .125 inch and a depth of not less than 3 inches.

2. Rungs/Treads. Knuckled or serrated aluminum bars, not less than 3/4 inch in diameter fabricated of alloy 6061-T6. Alternatively, serrated tubular aluminum extrusions of alloy 6063-T5/T6 not less than 1-1/4-inch square. Attach rungs to side rails with self-locking Type 316 stainless steel fasteners.

3. Wall/Floor Support Brackets. Aluminum plates, alloy 6061-T6. T316 fasteners/rigid attack/locking.

4. "Walk-through Roofover Rail Extensions". As detailed with square section tabular serrated grab rails.

## 2.02 LADDER SAFETY POST EXTENSION

A. Fixed ladders occurring below hatch doors shall be provided with attached telescoping tubular safety post extension, unless otherwise noted. Unit shall be completely assembled with stainless steel fasteners and brackets for securing to the ladder rungs provided by the manufacturer. Provide corrosion resistant construction.

B. Manufacturers:

1. Bilco - ladder UP Safety Post, Model 2 or equal.

## 2.03 FALL PREVENTION SYSTEM

A. Fall Prevention System

1. Provide complete rigid-rail and locking sleeve fall prevention system such as "Saf-T-Climb" by North Consumer Products (Division of Siebe North, Inc.) or equal at locations noted on the Drawings. System shall be complete with all mounting hardware and accessories furnished in the same metal as the rail unless otherwise noted.

2. Rail material shall be aluminum alloy 6061-T6 with bronze sleeves.

3. Provide basic system accessories including: two bronze locking climbing sleeves (Saf-T-Lok Sleeve) two climbing belts (Saf-T-Belt), two harnesses (Saf-T-Climb Harness), removable extension kit.

4. Where ladder begins below the access platform of a structure (e.g., meter vaults, hatchways, etc.) provide a permanently installed mandril at each ladder to allow use of the removable extension previously specified.

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B. Fabrication

1. Details shall be as shown on the Drawings and as specified.

2. Components shall be free of splinters, sharp edges, burrs or hazardous projections.

3. For ladders, round or cap top ends of side rails. Grinds welds on exterior face of side rails or stringers smooth. Accurately fabricate joints for neat, tight fit.

4. Attachments not made by welding shall be made with self-locking Type 316 stainless steel fasteners.

5. Mill finish unless otherwise noted. Ship with a shop coat of methacrylate lacquer.

PART 3: EXECUTION

3.01 INSTALLATION

A. Install ladders and accessories in compliance with manufacturer's shop drawings and detailed instructions.

B. Install fabrications, plumb, square and level and securely anchored to supports. Smooth and adjust miters and field cuts to assure tight joints.

C. Where aluminum contacts a dissimilar metal, apply to the dissimilar a heavy brush coat of zinc-chromate primer followed by two coats of aluminum metal and masonry paint.

D. Where aluminum contacts masonry or concrete, apply a heavy coat of acceptable alkali resistant paint bituminous or epoxy paint to the masonry or concrete.

3.02 PROTECTION

A. Protect aluminum fabrications from damage due to work of adjacent trades.

3.03 CLEANING

A. As work progresses, remove debris and leave installation sites broom clean.

B. Prior to final acceptance, clean ladders of any paint, mud or other adherents.

END OF SECTION

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SECTION 05530

# METAL GRATINGS AND COVER PLATES

## PART 1: GENERAL

### 1.01 SCOPE OF WORK

A. Furnish all labor, materials, equipment and incidentals required and install metal gratings and floor cover plates along with embedded or attached support frames as shown on the Drawings or as specified herein.

### 1.02 RELATED WORK

A. Metal Stairs including bar grating stair treads are specified in Section 05511.

B. Grating or cover plate intermediate support beams and anchoring devices for attaching these supports to concrete are included in Section 05500.

### 1.03 SUBMITTALS

A. Submit, in accordance with Section 01300, detailed shop drawings showing sizes of members, method of assembly, anchorage and connection to other members. Submittals shall include the following:

1. Manufacturer's product data for gratings and plates including span and deflection tables and details of construction.

2. Manufacturer's installation instructions.

### 1.04 REFERENCE STANDARDS

A. American Welding Society (AWS)

1. AWS D1.2 - Structural Welding Code Aluminum

B. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

### 1.05 QUALITY ASSURANCE

A. The work of this Section shall be completely coordinated with the work of other Sections. Verify at the site the dimensions and the work of other trades adjoining items of work in this Section before fabricating or installing the items specified.

B. Furnish to the pertinent trades all items included under this Section that are to be built into the work of other Sections.

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PART 2: PRODUCTS

2.01 RECTANGULAR ALUMINUM BAR GRATING AND APPURTENANCES

A. Provide aluminum grating of the depths and bearing bar thicknesses noted on the Drawings, with bearing bars spaced at 1-3/16-in. on center and cross bar supports at 4-in. on center. Grating material shall be aluminum alloy 6063-T6. Approved manufacturers are McNichols Co., Tampa, FL - GAL Series; or Seidelhuber Metal Products, Inc., San Carlos, CA - 19S4 Series.

1. Grating cross bars shall be attached to the bearing bars with interlocked swaged joints having no exposed welding.

2. Grating provided shall meet or exceed the following load and deflection criteria for the number of spans and span lengths at which it will be utilized:

a. The span at which the grating is installed shall not exceed the fabricator's maximum recommended span.

b. The grating shall produce a deflection of 1/4-in. or less under a uniform live load of 200-lbs/sq ft.

c. Grating shall produce a deflection of 1/4-in. or less under a concentrated live load of 300-lbs applied at mid span.

3. Openings 2-in. or greater in diameter/dimension and grating edges shall be banded with a bar of the same depth and thickness as the bearing bars. Cut bearing or cross bars shall be welded to the banding bar.

4. Provide trench grating with equal "stubs".

B. Grating, frames and supports shall be all aluminum construction, as shown on the Drawings and specified, fabricated from aluminum alloy 6061-T6.

C. Grating clamps, nuts, bolts, washers and other fastening devices for grating and grating supports shall be Type 316 stainless steel.

1. Provide saddle clip grating anchors.

D. Finishes

1. Grating and frames - Mill finish

2. Surface - Serrated

2.02 ALUMINUM COVER PLATES

A. Cover plates shall be aluminum tread plate, alloy 6061-T6 having a raised figure pattern on one surface to provide improved traction.

1. Unless otherwise noted, provide 3/8-in. plate thickness.

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B. Plate, frames and supports shall be all aluminum construction as shown on the Drawings and specified herein.

C. Cover plate fastening devices and hardware shall be Type 316 stainless steel.

D. Mill Finish

2.03 FABRICATION

A. Provide work true to detail, with clean, straight, sharply defined profiles and smooth surfaces of uniform color and texture free from defects impairing strength or durability.

B. Field verify dimensions prior to fabrication.

C. Provide connections and accessories of sufficient strength to safely withstand stresses and strains to which they will be subjected. Threaded connections shall be made so that the threads are concealed by fitting.

D. Angle frames for grating and floor plates shall be welded and mitered with welded strap anchors attached.

E. Welded joints shall be rigid and continuously welded or spot welded as specified or shown. Dress the face of welds flush and smooth. Exposed joints shall be close fitting and located where least conspicuous.

F. Welding of parts shall be in compliance with the latest edition of AWS D1.2. Welding only to be done where shown, specified, or permitted by the Engineer. Welding shall be done by welders certified to perform welding in accordance with the requirements of the AWS Code. Component parts of built up members to be welded shall be adequately supported and clamped or held by other adequate means to hold the parts in proper relation for welding.

G. Weld aluminum work on the unexposed side when possible in order to prevent pitting or discoloration.

H. Apply one coat of methacrylate lacquer to all aluminum before shipment from the factory.

PART 3: EXECUTION

3.01 INSPECTION

A. Verify that opening sizes and dimensional variations are acceptable for installation of grating or cover plates at the specified tolerances. Report any non complying areas to the Engineer prior to proceeding with installation.

3.02 INSTALLATION

A. Install all items furnished except items to be embedded in concrete which shall be installed under Division 3. Install items to be attached to concrete or masonry after such work is completed and in compliance with the details shown.

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B. Field cutting of finished surfaces is not allowed unless specifically approved by the Engineer. When cutting is approved, use mechanical cutting tools; do not use flame cutting tools.

C. Secure grating with fastening devices as specified to prevent movement, except where removable grating is called for on Drawings.

D. Where aluminum contacts a dissimilar metal, field apply a heavy brush coat of zinc chromate primer followed by two coats of aluminum metal and masonry paint to the dissimilar metal.

E. Where aluminum contacts masonry or concrete, field apply a heavy brush coat of zinc chromate primer to the masonry or concrete. For embedded items, coat the embed.

F. Where aluminum contacts wood, field apply two coats of aluminum metal and masonry paint to the wood.

3.03 FIELD QUALITY CONTROL

A. Tolerances

1. Maximum space between adjoining or abutting sections: 1/4-in.

2. Maximum variation from top surface plane of adjoining or abutting sections or structure: 1/8-in.

END OF SECTION

# *DIVISION 6*

# *WOOD AND PLASTICS*

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SECTION 06500

# FIBERGLASS REINFORCED STRUCTURAL PLASTICS

## PART 1 GENERAL

### 1.01 SCOPE OF WORK

A. The work covered by this section shall include materials and installation for the fiberglass reinforced plastic (FRP) Baffle Wall System, which includes but is not limited to:

1. FRP baffle wall panels
2. FRP columns
3. FRP angles
4. Column base plates/angles
5. Fasteners and connections

B. Provide FRP Baffle Wall System as shown on the Drawings for Aeration Basins No. 1, 2 and 3.

### 1.02 RELATED WORK

A. Miscellaneous Metals are included in Section 05500.

### 1.03 SUBMITTALS

A. Submit for approval, in accordance with Section 01300, complete shop drawings of all FRP components as specified herein. Include material strength and test data, physical properties, dimensions, chemical resistance test data, and material composition.

B. Drawings including layouts; connection and framing details; fastener types and spacing; product description.

C. Operation and maintenance data for the FRP Baffle Wall System.

D. For concrete anchor systems, submit allowable load tables and limits on spacing and edge distances as well as design calculations verifying the capacity of the proposed anchors is greater than applied design loads.

E. For FRP baffle wall systems, submit design calculations verifying the capacity of the wall system and all structural components to accommodate the design loads as specified herein. Include bracing reactions at the concrete basin walls for the Engineer to review.

### 1.04 REFERENCE STANDARDS

A. American Society for Testing and Materials (ASTM)

1. ASTM D 638 - Standard Test Method for Tensile Properties of Plastics

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2. ASTM D 790 - Standard Test Method for Flexural Properties of Plastics

3. ASTM D 570 - Standard Test Method for Water Absorption of Materials

4. ASTM D 256 - Standard Test Method for Izod Impact (Notched)

5. ASTM D792 - Standard Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement.

6. ASTM D2584 - Standard Test Method for Ignition Loss of Cured Reinforced Resins

7. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials

B. ACI 350.3, Seismic Design of Liquid-Containing Concrete Structures and Commentary, 2006 Edition.

C. All applicable national and local building codes.

1.05 QUALITY ASSURANCE

A. Contractor shall be responsible for verifying all field dimensions for development and approval of manufacturer's drawings.

B. Baffle system components (excluding any associated concrete items) shall be provided by a single manufacturer to insure coordination and compatibility of parts.

C. Manufacturer of baffle wall system shall have full responsibility for products and design. Split responsibility of materials or design is not acceptable.

D. Manufacturer of baffle wall system shall have completed within the last five years a minimum of five (5) projects of similar type as those required in this scope.

E. Baffle wall system shall be by Enduro Systems, Inc of Houston, Texas or approved equal.

1.06 DELIVERY AND STORAGE

A. Deliver and store materials in conformance with the manufacturer's recommendations.

B. At the time of delivery, all materials shall be inspected for shipping damage. The freight company and the Manufacturer shall be notified immediately of any damage or quantity shortages.

C. The Contractor shall protect FRP materials from cuts, scratches, gouges, abrasions, and impacts. When lifting crated FRP materials, spreader bars shall be used (not wire slings unless materials are fully protected). FRP components shall not be dragged across one another unless separated by a non-scratching spacer.

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1.07 DESIGN CRITERIA

A. Design Load: The load for design shall be the greater of water differential or wind load but not a combination of the two.

1. Water Differential: 2 inches. (Considered as a uniform load over the entire wall)

2. Wind Load: 15 Lbs./SF Uniform Load

B. Deflection Limits and Factors of Safety

1. Baffle Panels: L/D = 120 (not to exceed panel depth); Factor of Safety = 2.0

2. Columns: L/D = 120, Factor of Safety = 2.5

C. Baffle Wall Brace Reactions at Existing Basin Walls: Shall be limited to a 2000 lb horizontal reaction. No moment shall be transferred into the existing basin walls through the brace connections.

PART 2 PRODUCTS

2.01 MATERIALS AND PROPERTIES

A. FRP Baffle Panels shall exhibit these minimum properties:

| | | |
|---|---|---|
| Tensile Strength | 40,000 psi | ASTM D 638 |
| Flexural Strength | 45,000 psi | ASTM D 790 |
| Flexural Modulus | 1,690,000 psi | ASTM D 790 |
| Izod Impact (Notched) | 25 | ASTM D 256 |
| Water Absorption | .25% maximum | ASTM D 570 |

B. FRP Baffle Panels

1. FRP baffle panels shall be a ribbed profile in 4" depth x 24" height coverage (full panel dimension).

2. FRP baffle panels shall be a minimum of 1/8" (.125 inch) thick.

3. FRP baffle panels shall have (top) horizontal ribs that slope downward not less than 10 degrees to minimize sediment build-up.

4. FRP baffle panels shall comply with the structural requirements in Part 1.07 Design Criteria.

5. FRP material shall include glass fiber reinforcements 40% (minimum) of the material weight embedded within UV Stabilized Polyester Resin. Color shall be standard gray.

6. FRP material shall have a surfacing veil on both sides.

7. Factory cut edges and drilled holes shall be sealed with ANSI/NSF approved material.

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C. FRP Structural Framing / Angles

1. FRP framing shall comply with the structural requirements in Part 1.07 Design Criteria. FRP columns may be knee or top braced.

2. FRP angles shall be a minimum of 3/8" (.375 inch) thickness and 90 degrees.

3. FRP material shall include glass fiber reinforcements 50% (minimum) of the material weight embedded within UV Stabilized Polyester Resin. Color shall be standard gray.

4. FRP material shall have a surfacing veil on both sides.

5. Factory cut edges and drilled holes shall be sealed with ANSI/NSF approved material.

D. Other Structural Components

1. Column base plates or angles shall be: 316 Stainless Steel, refer to Specification Section 05500 for additional and more specific material requirements.

E. Hardware

1. Fasteners, anchorage, and other structural hardware shall be: 316 Stainless Steel

2. Panel fasteners shall be nut and bolt assembly with 1.25" diameter Fender washer.

3. All submerged anchors shall be epoxy adhesive type (size as required).

4. Refer to Specification Section 05500 for additional and more specific material and fastener information and requirements.

## PART 3 EXECUTION

### 3.01 INSTALLATION

A. Before placing and attaching components, the contractor shall confirm the alignment and location of column base plates, surfaces, brackets, saddles, etc. All bearing surfaces must be level, flat, clean and free of debris.

B. Erection shall proceed according to sequence shown on the approved drawings.

C. Contractor shall install pads, curbs or piers to modify uneven or sloped concrete surfaces to create a flat, level surface for baffle system attachment.

D. Contractor shall field cut materials as required and shown on the Manufacturer's drawings.

E. Contractor shall seal field cut edges with NSF approved material.

F. Contractor shall install beams and connections as shown on the approved layout drawings. Field modifications (cuts, copes, holes, etc.) unless shown on the drawings are not allowed without the manufacturer's written approval. Shim FRP beams with approved materials only.

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G. Before placement of baffle panels, contractor shall check alignment and location of FRP framing members and existing structure. Baffle panels shall be nested at side-lap conditions.

H. Contractor shall adjust FRP baffle panels for proper bearing and alignment. The first panel installed at the bottom of the wall must have the side with a flat end (not an upturn) at the bottom.

I. Contractor shall drill holes for fasteners through baffle panel and support beam.

J. Contractor shall fasten baffle panels to structural supports as shown on the approved layout drawings. Unless noted otherwise, FRP baffle panels shall be attached to each support with three (3) nut and bolt assemblies with 1.25" diameter Fender washers. At panel side laps, fastening shall be through two panels. Refer to manufacturer's installation instructions and drawings for proper fastener selection and procedure.

K. Prior to field drilling into existing concrete sections, verify the location of existing reinforcement to avoid damaging said reinforcement during installation. Follow all manufacturer's recommendations for post-installed anchor installation including, but not limited to, minimum edge distances and spacing.

L. Contractor shall seal field-drilled holes with NSF approved material.

M. Contractor shall place and fasten other miscellaneous components or hardware as shown on the approved drawings.

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# *DIVISION 9*

# *FINISHES*

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SECTION 09901

# SURFACE PREPARATION AND SHOP PRIME PAINTING

## PART 1 GENERAL

### 1.01 SCOPE OF WORK

A. Furnish all labor, materials, equipment and incidentals required for the surface preparation and application of shop primers on ferrous metals, excluding stainless steels, as specified herein.

### 1.02 RELATED WORK

A. Finish painting is included in Section 09902.

### 1.03 SUBMITTALS

A. Submit, in accordance with Section 01300, shop drawings, manufacturer's specifications and data on the proposed primers and detailed surface preparation, application procedures and dry mil thicknesses.

B. Submit representative physical samples of the proposed primers, if required by the Engineer.

### 1.04 REFERENCE STANDARDS

A. The Society for Protective Coatings (SSPC)

1. SSPC-SP 6/NACE No. 3 - Joint Surface Preparation Standard SSPC-SP 6/NACE No. 3: Commercial Blast Cleaning

2. SSPC-SP 10/NACE No. 2 - Joint Surface Preparation Standard SSPC-SP 10/NACE No. 2: Near-White Blast Cleaning.

B. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

## PART 2 PRODUCTS

### 2.01 MATERIALS

A. Submerged Surfaces - Shop primer for ferrous metals which will be in contact with water being treated, either submerged or which are subject to splash action or which are specified to be considered submerged service shall be shop primed with the following:

1. Shop Prime Coat: (Zinc Micaceous Iron Oxide Polyurethane Aromatic Shop Primer)

a. Carboline: Carboguard 888

b. Or approved equal.

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B. Non-Submerged Surfaces: Shop primer for ferrous metals which will not be in contact with water being treated, not submerged and not subject to splash action shall be shop primed with the following:

1. Shop Prime Coat: (Zinc Micaceous Iron Oxide Polyurethane Aromatic Shop Primer)

a. Carboline: Carboguard 888

b. Or approved equal.

C. Submerged Surfaces:

1. Shop Prime Coat for Ductile Iron Pipe: (Epoxy, Polyamidoamine Shop Primer)

a. Carboline: Carboguard 888

b. Or approved equal.

2. Shop Prime Coat for Ferrous Metal Surfaces: (Zinc Micaceous Iron Oxide Polyurethane Aromatic Shop Primer).

a. Carboline: Carboguard 888.

b. Or approved equal.

D. Non-Primed Surfaces - Gears, bearings surfaces and other similar surfaces obviously not to be painted shall be given a heavy shop coat of grease or other suitable rust-resistant coating. This coating shall be maintained as necessary to prevent corrosion during all periods of storage and erection and shall be satisfactory to the Engineer up to the time of the final acceptance test.

E. Compatibility of Coating Systems - Shop priming shall be done with primers that are guaranteed by the manufacturer to be compatible with their corresponding primers and finish coats specified in Section 09902 for use in the field and which are recommended for use together.

## PART 3 EXECUTION

### 3.01 APPLICATION

A. Surface Preparation and Priming

1. Non-submerged components scheduled for priming, as defined above, shall be blast cleaned in accordance with SSPC-SP 6/NACE No. 3, immediately prior to priming. Submerged components scheduled for priming, as defined above, shall be blast cleaned in accordance with SSPC-SP 10/NACE No. 2, immediately prior to priming. Consult manufacturer regarding required surface profiles.

2. Surfaces shall be dry and free of dust, oil, grease and other foreign material before priming.

3. Shop prime in accordance with approved manufacturer's recommendations.

B. Non-Primed Surfaces

1. Apply approved coating per manufacturer's recommendations.

3.02 FABRICATED ITEMS

A. All items to be shop primed shall be blast cleaned as specified for applicable service prior to priming. If, in the opinion of the Engineer, any prime coating that has been improperly applied or if material contrary to this Section has been used, that coating shall be removed by abrasive blasting to white metal and reprimed in accordance with this Section.

B. All shop prime coats shall be of the correct materials and applied in accordance with this Section. Remove any prime coats not in accordance with this Section by blast cleaning and apply the specified prime coat at no additional cost to the Owner.

C. Shop primed surfaces shall be cleaned thoroughly and damaged or bare spots prepared as approved and retouched with the specified primer before the application of successive paint coats in the field.

D. Shop finish coats, if proposed and allowed, shall be equal in appearance and protection quality to a field applied finish coat. If, in the opinion of the Engineer, a shop finish coat system does not give the appearance and protection quality of other work of similar nature, prepare the surfaces and apply the coat or coats of paint as directed by the Engineer to accomplish the desired appearance and protection quality. Submit to the Engineer substantial evidence that the standard finish is compatible with the specified finish coat.

E. Properly protect the shop prime and finish coats against damage from weather or any other cause.

F. Wherever fabricated equipment is required to be blast cleaned, protect all motors, drives, bearings, gears, etc, from the entry of grit. Equipment found to contain grit shall be promptly and thoroughly cleaned.

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# SECTION 09902

# FINISH PAINTING

## PART 1 GENERAL

### 1.01 SCOPE OF WORK

A. The work of this Section consists of furnishing all materials, labor, equipment, and incidentals required and performing all the finish painting necessary to complete this Contract in its entirety.

B. The work will be performed at an existing operating facility. It will be necessary that contaminants, including, but not limited to, dust from abrasive blasting, solvents, thinners, paints, coatings, sealers, cleaners, etc., shall be kept from the treatment process, and from the existing operating equipment, motors, valves, etc. The Contractor shall take whatever precautions are necessary to prevent contamination of the water at all times, and coordinate with the Engineer accordingly regarding any disruption to the treatment process. The Contractor shall be responsible for any contamination that may occur.

C. It is the intent of this Section to paint all concrete and precast concrete where noted or scheduled, exposed structural steel concrete masonry units and miscellaneous metal including galvanized steel, steel doors and frames, steel frames for glazed openings, pipe, fittings, supports, valves, mechanical and electrical equipment, roof fans, electrical conduit and appurtenances, gates, operators and posts, interior gypsum work, interior concrete masonry unit walls, exposed ductwork; all as specified herein, as indicated on the Drawings, and all other work obviously required to be finish painted unless otherwise specified. Minor items omitted in the schedule of work shall be included in the work of this Section where they come within the general intent of the specifications as stated herein.

D. Where scheduled/noted on the Drawings and where specified herein, existing areas and items that have been repaired or refurbished as part of the work shall be prepared for finish painting and painted. This includes said items in existing areas exterior, interior, and submerged. The finish paint systems to be used on existing surfaces are as scheduled for new surfaces herein. Surface preparation shall conform to Section 09901. Fillers, surfacers, and primers shall be as specified in Section 09901.

1. Prior to bidding, the Contractor shall field survey the existing conditions to identify full scale and scope of repainting work. Existing paint/coatings are present and all surfaces must be appropriately prepared as recommended by the manufacturer for proper adhesion and performance of the new paint systems.

2. Prior to bidding, the Contractor shall also determine if lead based products are present on the existing buildings that require repainting. If lead based products are found, the removal of such shall be included in the bid price.

E. Paint items so noted in paragraph 1.01C and D and in accordance with the Finish Paint Schedule and Color Coding Schedule herein. Contractor shall provide color chart to the Engineer for selection of colors that are not listed herein. Provide letters and numbers for markings as specified. Items noted in Finish Paint Schedule and Color Coding Schedule

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herein as having factory finish and other obviously factory finished items shall not be field painted. The Contractor is responsible for having damaged factory finish painted items repaired or, if so ordered, for replacing items. Preparation and field touch-up of abrasions, welds, and damage to primed or galvanized components after erection is included in the respective Sections of such factory finished items.

F. Furnish all material, labor, scaffolding and equipment required to complete all work shown on the Drawings and specified herein. Work includes painting and finishing of all new exterior and interior exposed items and surfaces and some refinishing of existing surfaces as specified or noted on the Drawings.

G. Paint all exposed surfaces except where the natural finish of the material is obviously intended and specifically noted as a surface not to be painted. Where items or surfaces are not specifically mentioned, paint these the same as adjacent similar materials or areas.

H. The following surfaces or items are not required to be painted:

1. Portions of metal, other than aluminum, embedded in concrete. This does not apply to the back face of items mounted to concrete or masonry surfaces which shall be painted before erection. Aluminum to be embedded in or in contact with concrete or masonry shall be coated to prevent electrolysis.

2. Stainless steel.

3. Concealed surfaces of pipe.

4. Finish hardware, except door closers that are not finished.

5. Cast-in-place or precast concrete surfaces, unless specified or noted otherwise.

6. Door hardware

7. Manhole frames and covers.

8. Fiberglass other than piping.

9. Packing glands and other adjustable parts, and nameplates and data plates of mechanical equipment.

10. PVC process piping that is installed inside a building or is otherwise shielded from UV degradation. Labeling of said piping is required per Section 2.07 of this Specification.

11. Do <u>not paint any code required</u> labels such as Underwriter's Laboratories and Factory Mutual or any equipment identification, performance rating, name or nomenclature plates.

12. Membrane roofing

13. Mechanical and electrical equipment that has been specified in Divisions 11, 13, and 16.

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I. Where rooms are shown in the finish schedule to have unfinished walls and ceilings, paint metal doors and frames and other miscellaneous items in these spaces.

J. Paint or paint coloring agents that contain mercury, asbestos or lead will not be permitted.

1.02 RELATED WORK

A. Waterproofing and Dampproofing are included in Section 07100.

B. Surface Preparation and Prime Painting are included in Section 09901.

C. Building Signage is included in Section 10400.

D. Concrete is included in Division 3.

E. Masonry is included in Division 4.

F. Metals are included in Division 5.

1.03 REFERENCES

A. American Association of State Highway and Transportation Officials (AASHTO)

B. American Society for Testing and Materials (ASTM)

1. ASTM C150 - Specification for Portland Cement

2. ASTM D4258 - Practice for Surface Cleaning Concrete for Coating

C. National Science Foundation (NSF): Standard 61

D. Occupational Safety and Health Act (OSHA): Air Pollution Control Rules and Color Coding.

E. Steel Structures Painting Council (SSPC)

1. SSPC-SP-1 - Surface Preparation Specification - Solvent Cleaning

2. SSPC-SP-2 - Surface Preparation Specification - Hand Tool Cleaning

3. SSPC-SP-3 - Surface Preparation Specification - Power Tool Cleaning

4. SSPC-SP-6 - Commercial Blast Cleaning

5. SSPC-SP-10 - Near White Metal Blast Cleaning

1.04 PRODUCT HANDLING

A. Deliver all materials to the job site in original, new and unopened packages and containers bearing manufacturer's name and label showing at least the following:

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1. Name or title of the material
2. Fed. Spec. number, if applicable
3. Manufacturer's name and stock number
4. Contents by volume for major constituents
5. Thinning instructions
6. Application instructions

B. Provide proper storage to prevent damage to, and deterioration of, paint materials.

C. Use all means necessary to protect the materials of this section before, during, and after installation and to protect the work and materials of all other trades.

D. In the event of damage, immediately make all repairs and replacements necessary to the approval of the Engineer and at no additional cost to the Owner.

1.05 JOB CONDITIONS

A. Surface temperatures: Do not apply solvent-thinned paints when the temperature of surfaces to be painted and the surrounding air temperature are below 45° F, unless otherwise permitted by the manufacturer's printed instructions as approved by the Engineer.

B. Weather conditions: Do not apply paint in snow, rain, fog, or mist; or when the relative humidity exceeds 85%; or to damp or wet surfaces, unless otherwise permitted by the manufacturer's printed instructions as approved by the Engineer. Applications may be continued during inclement weather within the temperature limits specified by the paint manufacturer during application and drying periods.

1.06 SUBMITTALS

A. Submit 5 copies of manufacturer's printed brochures showing the type of materials to be used for each painting system. Identify Engineers' system on brochures.

B. Submit to the Engineer for review in accordance with Section 01300 shop drawings, working drawings, and product data including manufacturer's specifications and data on the proposed paint systems and detailed surface preparation, application procedures and dry film thickness. Certify that the systems submitted meet all applicable volatile organic carbon regulations. Equivalent systems are to be submitted at no additional costs to meet any new regulations.

C. Submit to the Engineer for review in accordance with Section 01300 color cards, including standard and special colors, for initial color selections.

D. Schedule of Painting Operations: Submit to the Engineer for review a complete Schedule of Painting Operations within 90 days after the Notice to Proceed. This Schedule is imperative so that the various fabricators may be notified of the proper shop prime coat to apply. Properly notify and coordinate the fabricators' surface preparation and painting operations with these Specifications. This Schedule shall include for each surface to be painted, the brand name, the percent volume of solids, the coverage and the number of coats the Contractor proposes to use

in order to achieve the specified dry film thickness, and color charts. When the Schedule has been approved, apply all material in strict accordance with the approved Schedule and the manufacturer's instructions. Wet and dry paint film gauges shall be made available to the Engineer to verify the proper application while work is in progress.

1.07 SAMPLES

A. Before starting work, apply a sample of each color selected on at least 200 square feet of actual surface where color is to be used. Do not proceed with painting until samples are approved by Engineer.

1.08 SPARE MATERIAL

A. Furnish one unopened gallon can of each type and each color of paint used.

1.09 PRE-PAINTING CONFERENCE

A. Well in advance of commencement of painting operations, but after major equipment has been delivered, a pre-painting conference shall be held. All parties with an interest in the painting work shall attend, including the Contractor, the Manufacturer, the Owner, the Engineer, and the painting subcontractor. The Contractor shall contact each party and arrange the meeting.

B. The conference shall include an inspection of the areas to be painted by all parties and a discussion of the conformance of each area with the specifications. Important issues such as paint compatibility, environmental conditions, climate control systems, original primer, dry film thickness, and monitoring the number of coats that have been field applied shall be discussed and problems shall be resolved.

C. A written record of the meeting shall be submitted to the Engineer.

PART 2 PRODUCTS

2.01 PAINT MATERIALS

A. All painting materials shall be fully equal to those manufactured by Carboline Co. The painting schedule has been prepared on the basis of Carboline products and recommendations for applications. No brand other than Carboline will be considered for approval unless the brand and type of paint proposed for each item in the following schedule together with sufficient data substantiated by certified tests conducted at no expense to the Owner, to demonstrate its equality to the paint(s) named, is submitted in writing to the Engineer for approval within 30 days after the signing of the Notice to Proceed. The type and number of tests performed shall be subject to the Engineer's approval. Color availability to match those colors specified will also be considered as an important property for equality.

B. Provide the best quality grade of the various types of coatings as regularly manufactured by paint materials manufacturers approved by the Engineer. Materials not displaying the manufacturer's identification as a standard best-grade product will not be accepted.

C. Provide paints of durable and washable quality. Do not use paint materials which will not withstand normal washing as required to remove pencil marks, ink, ordinary soil, and similar material without showing discoloration, loss of gloss, staining, or other damage.

D. The Engineer will select colors to be used in the various types of paint specified and will be the sole judge of acceptability of the various glosses obtained from the materials proposed to be used in the work.

E. Provide undercoat paint produced by the same manufacturer as the finish coat. Use only the thinners recommended by the paint manufacturer and use only to the recommended limits. Insofar as practicable, use undercoat, finish coat, and thinner material as parts of a unified system of paint finish.

F. All painting materials shall be and used without adulteration and mixed, thinned, and applied in strict accordance with manufacturer's directions for the applicable materials and surface and with the Engineer's approval before using.

G. Shop priming shall be done with primers that are guaranteed by the manufacturer to be compatible with the finish paints to be used. Refer to Section 09901 for special primers.

H. Work areas will be designated by the Engineer for storage and mixing of all painting materials. Materials shall be in full compliance with the requirements of pertinent codes and fire regulations. Proper containers outside of the buildings shall be provided and used for painting wastes, and no plumbing fixture shall be used for this purpose.

I. All recommendations of the paint manufacturer in regard to the health and safety of workmen shall be followed.

2.02 PAINTING SCHEDULE

A. General: Painting required under this section is called for on the drawings. Paint types are defined below.

B. All colors will be selected by the Engineer from color charts submitted by the Contractor.

C. The following surfaces shall have the types of paint scheduled below applied at the dry film thickness (DFT) in mils per coat noted. Some colors will require an additional coat from what is listed to get the proper color coverage.

1. Flexible Coating - Exterior Masonry

   2 Coats: Flexxide (4 - 8 DFT per coat)

2. Ferrous metals submerged or subject to splashing

   2 Coats: 890 (6 DFT per coat)

3. Exterior non-submerged ferrous metals

   1 Coat: 890 (4 DFT)
   1 Coat: 133HB (3 - 4 DFT)

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4. Interior non-submerged ferrous metals

   2 Coats: 890 (4 - 6 DFT per coat)

5. Exterior galvanized, and non-ferrous metal

   1 Coat: Galoseal WB Primer (2 - 3 DFT)
   1 Coat: 133HB (3 - 4 DFT)

6. Interior galvanized, and non-ferrous metals

   1 Coat : Galoseal WB Primer 2-3 mils DFT
   1 Coats: 890 (2 - 3 DFT per coat)

7. Galvanized and non-ferrous metal submerged or subject to splashing

   2 Coats: 890 (4 - 6 DFT per coat)

8. Interior Exposed Masonry.

   1 Coat: Sanitile 100 (60-80 sq. ft./gal)
   2 Coats: 890 (4-6 DFT Per Coat)

9. Insulated Pipe (Block Insulation: Same systems only 3 coats at 2 - 3 DFT per coat)

   2 Coats: 3359 (3 DFT per coat)

10. Aluminum in contact with dissimilar materials

    1 Coat: Sanitile 120 (1 - 2 mils DFT)
    2 Coats: 890 (3 DFT per coat)

11. Plastic Piping - Exterior (Sanding mandatory)

    1 Coat: Sanitile 120 (4 DFT)
    1 Coat: 133HB (2.5 DFT)

D. Any surfaces not specifically named in the Schedule and not specifically accepted shall be prepared, primed and painted in the manner and with materials consistent with these Specifications. The Engineer shall select which of the manufacturer's products, whether the type is indicated herein or not, shall be used for such unnamed surfaces. No extra payment shall be made for this painting.

## 2.03 APPLICATION EQUIPMENT

A. For application of the approved paint, use only such equipment as is recommended for application of the particular paint by the manufacturer of the particular paint, and as approved by the Engineer.

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B. Prior to actual use of application equipment, use all means necessary to verify that the proposed equipment is actually compatible with the material to be applied and that the integrity of the finish will not be jeopardized by use of the proposed application equipment.

2.04 OTHER MATERIALS

A. All other materials, not specifically described but required for a complete and proper installation of the work of this Section, shall be new, first-quality of their respective kinds, and as selected by the Contractor subject to the approval of the Engineer.

2.05 COLOR CODING FOR PIPES AND EQUIPMENT

A. Color coding shall consist of color code painting and identification of all exposed conduits, trough items, and pipelines for the transport of gases, liquid, and semi-liquids including all accessories such as valves, insulated pipe coverings, fittings, junction boxes, bus bars, connectors, and all operating accessories which are integral to be whole functional mechanical pipe and electrical conduit system. Colors shall be as noted in the Color Coding Schedule included herein, as selected and approved by the Engineer.

B. All hangers and pipe support floor stands shall be painted the same color and with the same paint as the pipe it supports. The system shall be painted up to but not including the flanges attached to the mechanical equipment nor the flexible conduit connected to electrical motors. When more than one pipe system is supported on the same bracket, the bracket shall be painted the same color as the adjacent wall or ceiling. Colors shall be as noted in the Color Coding Schedule included herein, as selected and approved by the Engineer.

C. All systems which are an integral part of the equipment, that is originating from the equipment and returning to the same piece of equipment, shall be painted between and up to but not including, the fixed flanges or connections on the equipment.

D. The Color Code establishes, defines, and assigns a definite color for each category of pipe, pipelines, equipment, and other items that are not listed in the Color Coding Schedule shall be assigned a color by the Engineer and shall be treated as an integral part of the Contract, at no additional cost to the Owner.

E. Banding for pipes shall be as specified in the Color Coding Schedule. Bands shall be 2-in wide and spaced 5-ft on center, located on each end of the pipe title, at 2-ft from the title bands, and at wall penetrations.

F. All moving parts, drive assemblies, and covers for moving parts which are potential hazards shall be Safety Orange.

G. All safety equipment shall be painted in accordance with OSHA standards.

H. All inline equipment and appurtenances not assigned another color shall be painted the same base color as the piping. The pipe system shall be painted with the pipe color up to but not including the flanges attached to pumps and mechanical equipment assigned another color. Tanks shall be painted the color of the piping system that they serve, unless the tank is fiberglass and levels are monitored through the tank.

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I. All conduit shall be painted to match its background surface.

J. Control panels shall be factory finished.

K. Fire protection equipment and emergency stop apparatus shall be painted OSHA Red.

2.06 COLOR CODING SCHEDULE

A. Building surface colors shall be painted as scheduled in the Color Coding Schedule or as selected by the Engineer.

B. All colors will be selected by the Engineer from color charts submitted by the Contractor, based on the Color Coding Schedule herein.

| Piping System or Equipment | Solid Color | Color Band | Letter Code | Letter Color |
|---|---|---|---|---|
| Drain – Gravity (Sewage) | Black | - | Drain | White |
| Drain – Suction or Pressure (Process) | White | - | Drain | Black |
| Equipment – General | | | | |
| Gates & Operators | Black | - | - | - |
| Ventilation Units – Inside | Gray or Alum[6] | - | - | - |
| Ventilation Units – Outside | White | - | - | - |
| Fire Hydrants – Potable | Barrel & Dome– Red<br><br>Nozzle Cap, Top Nut, & Shield - Red | Dk Blue/ White[3] | PW | White |
| HVAC Unit | Dk Gray | - | - | - |
| Natural Gas | Red | - | NG | White |
| Sample – Sewage or Sludge | White | Brown | Sample | Black |
| Vent | White | - | Vent | Black |
| Vent (Sewage) | Black | - | Vent | White |
| Water – Fire | Dk Blue | - | Fire | White |
| Water – Plant Water Chlorinated | Lt Blue | Yellow | PWC | White |
| Water – Non Potable | Lt Blue | Brown | NPW | White |
| Water – Potable | Dk Blue | White | PW | White |
| Water – Service | Lt Blue | Red | SW | White |

2.07 LETTERING OF TITLES

A. Each pipe system shall be labeled with the name of the materials in each pipeline and alongside this an arrow indicating the direction of flow of liquids. Titles shall be as so described in attached schedule. Titles shall not be located more than 20-linear-ft apart and

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shall also appear directly adjacent to each side of any wall the pipeline breaches, adjacent to each side of the valve regulator, flowcheck, strainer cleanout, and all pieces of equipment.

B. Titles shall identify the contents by complete name. Identification title locations shall be determined by the Engineer but in general they shall be placed where the view is unobstructed and on the two lower quarters of pipe or covering where they are overhead. Title should be clearly visible from operating positions especially those adjacent to control valves.

C. Titles on equipment shall be applied at eye level on machines where possible or at the upper most broad vertical surface of low equipment. Where more than one piece of the equipment item to be titled exists, the items shall be numbered consecutively as indicated on the mechanical drawings or as directed by the Engineer; for example Pump No. 1, Pump No. 2, etc. Titles shall be composed and justified on the left hand side as follows:

Pump No. 1

D. Application of titles

1. The color of the titles shall be black or white, as approved, to best contrast with the color of the pipes and equipment and shall be stencil applied.

2. Stencil text is to be in ALL CAPS worded exactly as shown in the Schedule. Titles are to be printed in a single line.

3. Letter sizes:

| Outside Dia. of Pipe or Covering (in.) | Size of Legend Letters (in.) |
|---|---|
| 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 |
| More than 10 | 3-1/2 |

Equipment titles are to be 2" high.

4. Arrow sizes. Where "a" is equal to 3/4 of outside diameter of pipe or covering, the arrow shaft shall be 2 "a" long by 3/8 "a" wide. The arrow head shall be an equilateral triangle with sides equal to "a." Maximum "a" dimension shall be 6".

5. When using direction arrows, point arrowhead away from pipe markers and in direction of flow. If flow can be in both directions, use a double-headed directional flow.

## 2.08 METAL TAGS

A. For pipelines smaller than 3/4" in diameter, securely fasten metal tags, 2-1/2" by 1/2", of Birmingham or Stubs 17 gauge brass with lettering etched and filled with enamel. Tags shall be approved by the Engineer.

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2.09 FABRICATED EQUIPMENT

A. Unless otherwise indicated all fabricated equipment shall be shop primed and shop or field finished.

B. All items to be shop primed shall be thoroughly cleaned of all loose material prior to priming. If, in the opinion of the Engineer, any prime coating shall have been improperly applied or if material contrary to these Specifications shall have been used, that coating shall be removed by sandblasting to white metal and re-primed in accordance with these Specifications.

C. All shop prime coats shall be of the correct materials and applied in accordance with these Specifications. Remove any prime coats not in accordance with these Specifications by sandblasting and apply the specified prime coat at no additional cost to the Owner.

D. Shop primed surfaces shall be cleaned thoroughly and damaged or bare spots retouched with the specified primer before the application of successive paint coats in the field.

E. The Contractor shall be responsible for and take whatever steps are necessary to properly protect the shop prime and finish coats against damage from weather or any other cause.

F. A shop finish coat shall be equal in appearance and protection quality to a field applied finish coat. If, in the opinion of the Engineer, a shop finish coat does not give the appearance and protection quality of other work of similar nature, prepare the surfaces and apply the coat or coats of paint as directed by the Engineer to accomplish the desired appearance and protection quality. Submit to the Engineer substantial evidence that the standard finish is compatible with the specified finish coat.

G. Wherever fabricated equipment is required to be sandblasted, protect all motors, drives, bearings, gears, etc., from the entry of grit. Any equipment found to contain grit shall be promptly and thoroughly cleaned.

PART 3 EXECUTION

3.01 SURFACE CONDITIONS

A. All surfaces to be painted shall be prepared as specified herein and shall be dry and clean before painting.

B. All metal welds, blisters, etc., shall be ground and sanded smooth in accordance with SSPC-SP-10. All pits and dents shall be filled and all imperfections shall be corrected so as to provide a smooth surface for painting. All rust, loose scale, oil, grease, and dirt shall be removed by use of approved solvents, wire brushing, or sanding.

C. Concrete block surface shall be smooth and cleaned of all dust, efflorescence, chalk, loose mortar, dirt, grease, oil, tar, and other foreign matter, conforming to ASTM D4258.

D. All plastic pipe surfaces shall be lightly sanded before painting.

E. Exposed Pipe: Bituminous coated pipe shall not be used in exposed locations. Pipe which shall be exposed after project completion shall be primed in accordance with the requirements

herein. Any bituminous coated pipe which is inadvertently installed in exposed locations shall be sandblasted clean before priming and painting. After installation all exterior, exposed flanged joints shall have the gap between adjoining flanges sealed with a single component polysulfide sealant to prevent rust stains.

F. Primed or Previously Painted Surfaces and Nonferrous Surfaces: All coated surfaces shall be cleaned prior to application of successive coats. All nonferrous metals not to be coated shall be cleaned. This cleaning shall be done in accordance with SSPC-SP-1, Solvent Cleaning.

G. Shop-Finished Surfaces: All shop-coated surfaces shall be protected from damage and corrosion before and after installation by treating damaged areas immediately upon detection. Abraded or corroded spots on shop-coated surfaces shall be "Hand Cleaned" and then touched up with the same materials as the shop coat. All shop coated surfaces which are faded, discolored, or which require more than minor touch-up in the opinion of the Engineer shall receive new surface preparation before being repainted. Cut edges of galvanized sheets and exposed threads and cut ends of galvanized piping, electrical conduit, and metal pipe sleeves, that are not to be finished painted, shall be "Solvent Cleaned" and primed with zinc dust-zinc oxide metal primer.

H. Galvanized and Zinc-Copper Alloy Surfaces: These surfaces to be painted shall be "Solvent Cleaned" and treated as hereinafter specified. Such surfaces not to be painted shall be "Solvent Cleaned."

I. Aluminum embedded or in contact with concrete must be painted according to the schedule for aluminum in contact with dissimilar materials.

J. Wood Surfaces: Clean all wood surfaces until they are free from dirt, oil, and all other foreign substance. Smooth all finished wood surfaces exposed to view, using the proper sandpaper. Where so required, use varying degrees of coarseness in sandpaper to produce a uniformly smooth and unmarred wood surface.

K. Cement Panel Ceilings: Apply one coat of USG Exterior Basecoat as recommended by the manufacturer. After recommended drying time, trowel apply USG Exterior Textured finish in a 1/16" minimum thick, uniform layer over all basecoat surfaces.

L. Do not proceed in areas of discrepancy until all such discrepancies have been fully resolved.

3.02 MATERIAL PREPARATION

A. Mix and prepare painting materials in strict accordance with the manufacturer's recommendations as approved by the Engineer.

B. Store materials not in actual use in tightly covered containers.

C. Maintain containers used in storage, mixing, and application of paint in a clean condition, free from foreign materials and residue.

D. Stir all materials before application to produce a mixture of uniform density, and as required during the application of materials. Do not stir into the material any film which may form on the surface. Remove the film and, if necessary, strain the material before using.

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3.03 SURFACE PREPARATION

A. General:

1. Perform all preparation and cleaning procedures in strict accordance with the paint manufacturer's recommendations as approved by the Engineer.

2. Remove all removable items which are in place and are not scheduled to receive paint finish, or provide surface-applied protection prior to surface preparation and painting operations.

3. Following completion of painting in each space or area, reinstall the removed items by using workmen skilled in the necessary trades.

4. Clean each surface to be painted prior to applying paint or surface treatment.

5. Remove oil and grease with clean cloths and cleaning solvents of low toxicity and a flash point in excess of 38° F. prior to start of mechanical cleaning.

6. Schedule the cleaning and painting so that dust and other contaminants from the cleaning process will not fall onto wet, newly painted surfaces.

7. Properly prepare existing surfaces to be painted by cleaning, sanding and priming to produce results equal to that of new work. The existing steel and other materials shown to remain need extensive cleaning.

B. Preparation of metal surfaces:

1. Thoroughly clean all surfaces until they are completely free from dirt, oil and grease.

2. On galvanized surfaces, use solvent for the initial cleaning and then treat the surface thoroughly with phosphoric acid etch. Remove all etching solution before proceeding.

3. Touch-up shop-applied prime coats wherever damaged, dirty, or bare (all steel). Wire-brush, solvent clean, and touch-up with the same type shop primer.

4. Allow to dry thoroughly before application of paint.

3.04 PAINT APPLICATION

A. General:

1. Slightly vary the color of succeeding coats. Do not apply additional coats until the complete coat has been inspected and approved. Only the inspected and approved coats of paint will be considered in determining the number of coats applied.

2. Sand and dust between enamel coats to remove all defects visible to the unaided eye from a distance of five feet.

3. On all removable panels and all hinged panels, paint the back sides to match the exposed sides.

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4. Paint interior surfaces of ducts, where visible through registers or grilles, with a flat, non-specular black paint, before final installation of equipment.

B. Drying:

1. Allow sufficient drying time between coats. Modify the period as recommended by the material manufacturer to suit adverse weather conditions.

2. Oil-base and oleo-resinous solvent-type paints shall be considered dry for recoating when the paint feels firm, does not deform or feel sticky under moderate pressure of the thumb, and the application of another coat of paint does not cause lifting or loss of adhesion of the undercoat.

C. Brush application:

1. Brush out and work all brush coats onto the surfaces in an even film. Cloudiness, spotting, holidays, laps, brush marks, runs, sags, ropiness, and other surface imperfections will not be acceptable.

D. Spray application:

1. Confine spray application to metal framework and similar surfaces where hand brush work would be inferior.

2. Wherever spray application is used, apply each coat to provide the equivalent hiding of brush-applied coats. Do not double back with spray equipment for the purpose of building up film thickness of two coats in one pass unless noted otherwise in this specification.

E. Roller Application:

1. Use roller application on interior wall and ceiling finishes when recommended by the manufacturer. Apply each roller coat to provide the equivalent hiding as brush-applied coats.

F. Completed work:

1. Completed work shall match the approved samples for color, texture, and coverage. Remove, refinish, or repaint all work not in compliance with specified requirements.

END OF SECTION

# *DIVISION 10*

# *SPECIALITIES*

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SECTION 10400

SIGNAGE

PART 1 GENERAL

1.01 SCOPE OF WORK

A. Furnish all labor, materials, equipment and incidentals required and install signage as specified and scheduled herein.

B. The types to be furnished are as follows:

1. Room identification signs.

2. Facility signs

(a) "AERATION DISTRIBUTION STRUCTURE" Identification Sign
(b) "AERATION BASIN NO.3" Identification sign
(c) "SECONDARY CLARIFIER NO. 3" Identification sign

1.02 RELATED WORK

A. Piping and equipment identification is specified in Section 09902.

B. Exit signs are included in Division 16.

1.03 SUBMITTALS

A. Submit, in accordance with Section 01300, shop drawings showing details of construction and erection. Submittals shall include the following:

1. Manufacturer's complete color range and type styles.

2. Sign layout with shop drawings as follows:

a. Scale layout of all site signs.

b. Full size layout of typical Room Identification and Restrictive signs.

c. Full size layout and text of Dedication Plaque.

3. Submit two each of the following samples. Samples shall be resubmitted as required until approved.

a. A Full-size sample of proposed pressure sensitive vinyl sign for Room Identification in the colors proposed for the required color scheme.
b. A sample (at least two full-size letters) of proposed Facility Sign showing details of construction and attachment.

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c. A 24 $in^2$ (minimum) corner sample of proposed Dedication Plaque showing material, edge detail, lettering and proposed mounting device.

d. A full-size sample of proposed restrictive signage with proposed mounting.

4. Cleaning and maintenance instructions for all signage components.

PART 2 PRODUCTS

2.01 MATERIALS

A. Room Identification signs

1. Signs made by ASI Sign Systems, Architectural Graphics Inc., or Seton Name Plate Co. or equal will suffice for this purpose. Catalog numbers indicated are those of ASI Sign Systems, (ASI) unless otherwise indicated. All lettering shall be Optima Bold, upper and lower case and sized as specified or as approved. All exposed surfaces shall be matte finish as approved.

2. Pressure sensitive letter type, (ASI, LTV Series, applied directly to doors. All letters shall be 2-in high as scheduled and located as directed. Letters shall be die-cut from 3.5 mil thick, pressure sensitive vinyl film and pre-spaced on carrier tape. The adhesive and finish surface shall be protected with one-piece removable liners. Color shall be white or black as selected depending on substrate color and in upper case letters.

3. The required number and legend of these Signs are described in Attachment 1 and shown on Figure 1.

B. Facility Signs

1. The three facility signs will consist of 6" flat-cut aluminum letters directly mounted to the surface of the building, and in a color that stands out well from the surface.

C. Restrictive Signs

1. Signs shall be 20 gauge galvanized steel backed butyrate by Seton Name Plate Corp. or equal. Signs shall be mounted with two strips 1/32-in two sided vinyl tape on doors and smooth surfaces and with two strips approved liquid adhesive with temporary hold by two strips vinyl tape on rough surfaces, each continuous across back.

2. Restrictive signs shall conform with OSHA regulations for accident prevention and shall have square corners. Size of sign 10-in high by 14-in.

3. The required number and legend of these Signs are described in Attachment 1 and shown on Figure 1

PART 3: EXECUTION

3.01 INSTALLATION

A. Signage shall be installed at the locations detailed or as directed above, in accordance with the manufacturer's recommendations and approved shop drawings.

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B. Dedication plaque shall be installed into holes drilled in masonry with waterproof cement in accordance with the approved shop drawings. Plaque shall be flush with wall. Locate on interior as directed.

C. Signage shall be located as follows:

1. Type U Door Signs shall be located on the exit side of doors, centered 60 in above the floor, justified to a line, 3 in from the strike edge of unglazed doors, 2 in from the glazing stop of narrow glazed openings, or on the glazed panel 2 in from the glazing stop on the strike edge of glazed doors.

2. Type V Door Signs shall be located on the entrance side of doors, centered 60 in above the floor, justified to a line, 3 in from the strike edge of unglazed doors, 2 in from the glazing stop of narrow glazed openings, or on the glazed panel 2 in from the glazing stop on the strike edge of glazed doors.

3. Type W Door Signs shall be located 3" above the top edge of the doors on the exit side.

D. Damaged units or components shall be removed and replaced at no additional cost to the Owner.

E. Signage shall be cleaned to the satisfaction of the Engineer using the approved methods, upon completion of the installation and again, just prior to acceptance of the project.

END OF SECTION

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SECTION 10520

FIRE PROTECTION SPECIALTIES

PART 1 GENERAL

1.01 SCOPE OF WORK

A. Furnish all labor, materials, equipment and incidentals required and install fire protection specialties complete as shown on the drawings and as specified herein.

B. This Section includes portable, hand-carried fire extinguishers and mounting brackets for fire extinguishers.

C. Owner-Furnished Material: Hand-carried fire extinguishers.

1.02 RELATED WORK

A. Interior Lighting for fire extinguisher location lights are included in Division 16.

1.03 SUBMITTALS

A. Submit, in accordance with Section 01300, detailed information on materials proposed and installation methods.

B. Product Data: For each type of product indicated. Include rating and classification, material descriptions, dimensions of individual components and profiles, and finishes for fire extinguisher and mounting brackets.

C. Product Schedule: For fire extinguishers. Coordinate final fire extinguisher schedule with mechanical contractor to ensure proper placement.

D. Operation and Maintenance Data: For fire extinguishers to include in maintenance manuals.

E. Warranty: Sample of special warranty.

1.04 REFERENCES

A. American Architectural Manufacturers Association (AAMA)

1. AAMA 611 - Voluntary Specification for Anodized Architectural Aluminum

2. AAMA 2603 - Voluntary Specification, Performance Requirements and Test Procedures for Pigmented Organic Coatings on Aluminum Extrusions and Panels

B. ASTM International (ASTM)

1. ASTM A 666 - Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar

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2. ASTM A 1008/A 1008M - Specification for Steel Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability

3. ASTM B 36/B 36M - Specification for Brass Plate, Sheet, Strip, and Rolled Bar

4. ASTM B 209 - Specification for Aluminum and Aluminum-Alloy Sheet and Plate

5. ASTM B 221 - Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes

6. ASTM C 1036 - Specification for Flat Glass

7. ASTM C 1048 - Specification for Heat-Treated Flat Glass - Kind HS, Kind FT Coated and Uncoated Glass

8. ASTM D 4802 - Specification for Poly(Methyl Methacrylate) Acrylic Plastic Sheet

9. ASTM E 814 - Test Method for Fire Tests of Through-Penetration Fire Stops

C. National Association of Architectural Metal Manufacturers

1. Metal Finishes Manual for Architectural and Metal Products.

D. NFPA (NFPA)

1. NFPA 10 - Portable Fire Extinguishers

2. NFPA 70 - National Electrical Code

E. SSPC: The Society for Protective Coatings (SSPC)

1. SSPC-SP 8 - Surface Preparation Specification No. 8: Pickling

2. SSPC-SP 5/NACE No. 1 - Joint Surface Preparation Standard SSPC-SP 5/NACE No. 1: White Metal Blast Cleaning

F Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.05 QUALITY ASSURANCE

A. NFPA Compliance: Fabricate and label fire extinguishers to comply with NFPA 10, "Portable Fire Extinguishers."

B. Fire Extinguishers: Listed and labeled for type, rating, and classification by an independent testing agency acceptable to authorities having jurisdiction.

1. Provide fire extinguishers approved, listed, and labeled by FMG.

C. Fire-Rated, Fire Protection Cabinets: Listed and labeled to comply with requirements in ASTM E 814 for fire-resistance rating of walls where they are installed.

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D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

E. Preinstallation Conference: Conduct conference at Project site.

1. Review methods and procedures related to fire extinguishers including, but not limited to, the following:

a. Schedules and coordination requirements.

1.06 COORDINATION

A. Coordinate size of fire protection cabinets to ensure that type and capacity of fire extinguishers indicated are accommodated.

B. Coordinate size of fire protection cabinets to ensure that type and capacity of fire hoses, hose valves, and hose racks indicated are accommodated.

C. Coordinate sizes and locations of fire protection cabinets with wall depths.

1.07 SEQUENCING – NOT USED

1.08 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace fire extinguishers that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Failure of hydrostatic test according to NFPA 10.

b. Faulty operation of valves or release levers.

2. Warranty Period: Six years from date of Completion.

PART 2 PRODUCTS

2.01 PORTABLE, HAND-CARRIED FIRE EXTINGUISHERS

A. Fire Extinguishers: Type, size, and capacity for each mounting bracket indicated.

1. Manufacturers: Provide products by one of the following:

a. Amerex Corporation.

b. Ansul Incorporated; Tyco International Ltd.

c. Badger Fire Protection; a Kidde company.

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d. Buckeye Fire Equipment Company.

e. Fire End & Croker Corporation.

f. J. L. Industries, Inc.; a division of Activar Construction Products Group.

g. Kidde Residential and Commercial Division; Subsidiary of Kidde plc.

h. Larsen's Manufacturing Company.

i. Moon-American.

j. Pem All Fire Extinguisher Corp.; a division of PEM Systems, Inc.

k. Potter Roemer LLC.

l. Pyro-Chem; Tyco Safety Products.

m. Or equal.

3. Valves: Manufacturer's standard.

4. Handles and Levers: Manufacturer's standard.

5. Instruction Labels: Include pictorial marking system complying with NFPA 10, Appendix B.

B. Multipurpose Dry-Chemical Type in Aluminum Container: UL-rated 3-A:40-B:C, 6-lb nominal capacity, with monoammonium phosphate-based dry chemical in enameled-aluminum container.

2.02 MOUNTING BRACKETS <Insert drawing designation>

A. Mounting Brackets: Manufacturer's standard[ galvanized] steel, designed to secure fire extinguisher to wall or structure, of sizes required for types and capacities of fire extinguishers indicated, with plated or [red] [black] baked-enamel finish.

1. Manufacturers: Provide products by one of the following:

a. Amerex Corporation.

b. Ansul Incorporated; Tyco International Ltd.

c. Badger Fire Protection; a Kidde company.

d. Buckeye Fire Equipment Company.

e. Fire End & Croker Corporation.

f. J. L. Industries, Inc.; a division of Activar Construction Products Group.

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g. Larsen's Manufacturing Company.

h. Potter Roemer LLC.

i. Or equal.

B. Identification: Lettering complying with authorities having jurisdiction for letter style, size, spacing, and location. Locate as indicated by Engineer.

1. Identify bracket-mounted fire extinguishers with the words "FIRE EXTINGUISHER" in red letter decals applied to mounting surface.

a. Orientation: Vertical.

## PART 3 EXECUTION

### 3.01 EXAMINATION

A. Examine fire extinguishers for proper charging and tagging.

1. Remove and replace damaged, defective, or undercharged fire extinguishers.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.02 PREPARATION (NOT USED)

### 3.03 INSTALLATION

A. General: Install fire extinguishers and mounting brackets in locations indicated and in compliance with requirements of authorities having jurisdiction.

1. Mounting Brackets: 54 inches above finished floor to top of fire extinguisher.

B. Mounting Brackets: Fasten mounting brackets to surfaces, square and plumb, at locations indicated.

### 3.04 ADJUSTING AND CLEANING

A. Remove temporary protective coverings and strippable films, if any, as fire protection cabinets are installed unless otherwise indicated in manufacturer's written installation instructions.

B. Adjust fire protection cabinet doors to operate easily without binding. Verify that integral locking devices operate properly.

C. On completion of fire protection cabinet installation, clean interior and exterior surfaces as recommended by manufacturer.

D. Touch up marred finishes, or replace fire protection cabinets that cannot be restored to factory-finished appearance. Use only materials and procedures recommended or furnished by fire protection cabinet and mounting bracket manufacturers. Replace fire protection cabinets that

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have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures

END OF SECTION

# DIVISION 11

# EQUIPMENT

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SECTION 11282

# SLIDE GATES AND WEIR GATES

## PART 1 GENERAL

### 1.01 SCOPE OF WORK

A. Furnish all labor, materials, equipment and incidentals required and install complete, slide gates, weir gates, operators, operating systems and appurtenances as shown on the Drawings and as specified herein.

### 1.02 SUBMITTALS

A. Submit, in accordance with Section 01300, shop drawings and product data showing materials of construction and details of installation for:

1. Complete description of all materials.
2. Certified shop and installation drawings showing all details of construction, dimensions and anchor bolt locations.
3. Descriptive literature, bulletins and/or catalogs of the equipment.
4. A complete bill of materials.
5. The weight of each component.
6. Description of surface preparation and shop prime painting of gates and accessories.

B. In the event it is not possible to conform to certain details of this Section, describe completely all non-conforming aspects.

C. Operation and Maintenance Data

1. Operating and maintenance instructions for each type of equipment shall be furnished to the Engineer as provided for in Section 01730.

### 1.03 REFERENCE STANDARDS

A. American Society for Testing and Materials (ASTM)

B. National Electrical Manufacturers Association (NEMA)

C. Aluminum Association, Inc. (AA)

D. Factory Mutual (FM)

E. Underwriters Laboratories (UL)

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F. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.04 QUALITY ASSURANCE

A. The slide gates, weir gates, operators, operating stems and appurtenances specified under this Section shall be furnished by manufacturers who are fully experienced, reputable and qualified in the manufacture of the equipment furnished. The slide gates, weir gates, operators, operating stems and all related equipment shall be designed, constructed and installed in accordance with the best practices and methods.

B. A factory representative who has complete knowledge of proper operation and maintenance of the equipment provided under this section shall be provided for one 8-hour day to instruct representatives of the Owner and Engineer on the proper operation and maintenance of the equipment. This work may be conducted in conjunction with the inspection of the installation and test runs as provided under PART 3.

C. This instruction period shall be scheduled with the Owner at least 10 days in advance and shall take place prior to start-up and acceptance by the Owner.

1.05 SYSTEM DESCRIPTION

A. The items furnished under this Section shall be of the sizes and have the characteristics as noted in the following Sluice Gate and Stop Log Schedules.

**Weir Gate Schedule**

| Sluice Gate Number | Location | Size Width by Height (inches) | Maximum Seating Head (feet) | Maximum Unseating Head (feet) | Operator Type |
|---|---|---|---|---|---|
| WG-01<br>WG-02 | Primary Splitter Box No. 1 | 48 x 48 | 5 | 5 | Electric Operator, Type 4A |
| WG-04<br>WG-05<br>WG-06<br>WG-07 | Secondary Clarifier Distribution Structure | 36 x 36 | 5 | 5 | Manual Handwheel |

Note: Provide wall thimbles for each sluice gate. See Drawings for installation conditions.

PART 2 PRODUCTS

2.01 STAINLESS STEEL SLIDE GATES AND DOWNWARD OPENING WEIR GATES

A. The slide gates, weir gates and stop plates shall have the characteristics and dimensions as shown on the drawings and additional information located in the Appendix.

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B. The stainless steel slide gates and accessories shall be fabricated Type 316 stainless steel self-contained type with the disc arranged to lower or raise to open and with the guides designed to mount on the face of, or embedded in concrete.

C. The guides shall be of Type 316 stainless steel construction. The guides shall be designed for maximum rigidity, shall have a weight of not less than 3 lbs/ft and will be provided with holes for anchor bolts every 18-in for face mounted units or embedding keyways for embedded units. Guides shall extend beneath the opening a sufficient amount to support the disc in the fully down or open position for downward opening gates.

D. An angle shall be welded to the guides across the invert of the opening on face-mounted gates and up both sides of all gates. A hollow bulb "J" or "P"-seal will be attached to this angle with stainless steel strips and attaching bolts. The seal shall be arranged so that it will deflect a minimum of 1/16-in. Angle, strips and bolts shall be the same material as the guides.

E. The operating stem shall be Type 316 stainless steel with a minimum diameter of 1-1/2-in designed to withstand at least twice the rated output of the operator. The slenderness ratio (l/r) shall be less than 200.

F. Where the guides extend above the operating floor, they shall be sufficiently strong so that no further reinforcing will be required. Where required, the yoke to support the operating benchstand will be formed by two angles welded at the top of the guides to provide a one-piece rigid frame. The arrangement of the yoke will be such that the disc and stem can be removed without disconnecting the yoke.

G. The disc or sliding member shall be of Type 316 and the stainless steel plate reinforced with "U" or angle-shaped stainless steel members welded to the plate not more than 16-in apart. The disc shall not deflect more than 1/360 of the span of the gate under the design head. Reinforcing ribs shall extend into the guides so that they overlap the seating surface of the guide. A specially molded resilient seal shall be mounted on the bottom of embedded unit discs or on the edge of the disc to provide flush bottom closure. The shape of the seal shall produce a seating surface having a minimum width of 3/4-in and the seal shall extend into the secondary slot of the guide. The vertical face of the seal shall be in contact with the seating surface of the guide to provide a proper seal at the corners. Reinforcements, retainer and bolts shall be of the same material as the disc. The invert of embedded unit frames shall have an angle welded to the lower ends of the guides to form a seating surface for a resilient seal mounted on the disc. Angle shall be of the same material as the guides.

H. All parts of the gate shall have a minimum thickness of 1/4-in.

I. Manual actuator shall be a yoke mounted, manual, non-geared, handwheel operator with rising Type 316 stainless steel stem, stem guide and clear plastic stem cover. Handwheel operators shall have a minimum 18-in diameter handwheel and shall operate the gate under the specified operating head with not greater than 40 lbs of force on the handwheel. Operators shall be equipped with fracture-resistant clear butyrate plastic stem covers which shall not discolor or become opaque for a minimum of 5 years after installation. The top of the stem cover shall be closed. The bottom end of the stem cover shall be mounted in a housing or adapter plate for easy field mounting. Stem covers shall be complete with indicator markings to indicate gate position. An arrow with the word "OPEN" shall be permanently attached or cast onto the

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operator to indicate the direction or rotation to open the gate. The direction of rotation to open shall be clockwise.

J. Electric actuators shall meet requirements in specification 15101.

J. All necessary attaching bolts and anchor bolts shall be Type 316 stainless steel and shall be furnished by the slide gate manufacturer.

K. Stainless steel slide gates shall be Series 900 as manufactured by Whipps, Inc.; Athol, MA and distributed by Tasco Associates, Kinnelon, NJ, or approved equal.

PART 3 EXECUTION

3.01 INSTALLATION

A. Installation of all gates and guides shall be done in a workmanlike manner. Handle, store and install the equipment specified in this Section in strict accordance with the manufacturer's drawings and recommendations. Frames and guides shall be installed in a true vertical plane and shall be installed with 90 degree corners.

B. Gates with embedded guides and inverts shall be installed in accordance with the recommendations of the manufacturer subject to the Engineer's approval.

C. The installation of all gates shall be under the supervision of a representative of the manufacturer furnishing the gates.

3.02 FIELD TESTING

A. Furnish the services of a factory representative, as provided under PART 1, who has complete knowledge of proper operation and maintenance to inspect the final installation and supervise a test of the equipment. These services may be combined with those provided under PART 1.

B. After installation, all slide gates and weir gates shall be field tested at maximum differential head to ensure that all items of equipment are in compliance with this Section, including the leakage requirements.

1. Maximum allowable leakage for slide gates and weir gates shall be 0.1 gpm/ft of perimeter under the design seating head.

C. In the event that any unit fails to meet the above requirements, the necessary changes shall be made and the unit retested. If the unit remains unable to meet the test requirements to the satisfaction of the Engineer, it shall be removed and replaced with a satisfactory unit at no additional cost to the Owner.

END OF SECTION

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SECTION 11285

SLUICE GATES

PART 1 GENERAL

1.01 SCOPE OF WORK

A. Section Includes: Sluice gates, stop logs, operators, operating stems, wall thimbles, and/or appurtenances as shown on the Drawings and/or as specified herein.

1.02 RELATED WORK

A. Operating and Maintenance Data is included in Section 01730.

B. Training Requirements are included in Section 01730.

C. Paint is included in Division 9.

1.03 SUBMITTALS

A. Submit, in accordance with Section 01300, copies of all materials required to establish compliance with the Specifications. Submittals shall include the following:

1. Complete description of all materials.

2. Certified shop and installation drawings showing all details of construction, dimensions, and anchor bolt locations and sizes.

3. Descriptive bulletins, and/or catalogs of the equipment.

4. Sluice gate operator information as specified in Div 11.

5. Installation instructions for sluice gates and stop log guides and logs.

B. Operating and maintenance instructions, for sluice gates, operators, and actuators, shall be furnished to the Engineer as provided for in Section 01730.

C. A list of the manufacturer's recommended set of spare parts and prices required for normal operation and maintenance shall be furnished with the equipment by the manufacturer.

1.04 QUALITY ASSURANCE

A. The items specified under this Section shall be furnished by manufacturers with at least 5 years experience with three satisfactory references from similar projects during the previous year.

B. All sluice gates shall be provided by a single manufacturer.

C. All stop logs shall be provided by a single manufacturer.

1.05 SYSTEM DESCRIPTION

A. The items furnished under this Section shall be of the sizes and have the characteristics as noted in the following Sluice Gate and Stop Log Schedules.

**Sluice Gate Schedule**

| Sluice Gate Number | Location | Size Width by Height (inches) | Maximum Seating Head (feet) | Maximum Unseating Head (feet) | Operator Type |
|---|---|---|---|---|---|
| SG-01<br>SG-02<br>SG-03 | Aeration Basin Distribution Structure | 36 x 36 | 17 | 17 | Manual Handwheel |
| SG-04<br>SG-05 | Splitter Box No. 3 | 30 x 30 | 15.5 | 15.5 | Manual Handwheel |
| SG-06<br>SG-07 | Splitter Box No. 4 | 30 x 30 | 15.5 | 15.5 | Manual Handwheel |

Note: Provide wall thimbles for each sluice gate. See Drawings for installation conditions.

PART 2 PRODUCTS

2.01 MANUFACTURERS OF SLUICE GATES

A. Sluice Gates

1. Rodney Hunt Company.
2. Waterman Industries Inc.
3. Golden Harvest, Inc. Golden Gates
4. Hydrogate.
5. Or approved equal.

2.02 SLUICE GATE MATERIALS AND EQUIPMENT - GENERAL

A. Unless otherwise noted, all sluice gate anchor bolts, nuts and washers shall be ASTM A276, Type 316 stainless steel.

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2.03 SLUICE GATES OPERATORS

A. Sluice gates shall be either cast iron conforming to AWWA C501 or heavy duty Type 304 stainless steel, except as otherwise specified herein, and complying with the information noted in the Sluice Gate Schedule above and the respective paragraphs herein. Sluice gates shall have wedging systems. Sluice gates without wedging systems shall not be allowed.

B. Manual and electric operators shall be provided for all sluice gates.

1. Floor stands shall be cast-iron or fabricated steel construction. The pedestal height shall be such that the crank shaft will be approximately 36-in above the operating floor. Provide necessary 1:1 gear boxes and shafts to assure crank shaft height above floor meets this requirement. Chain and sprocket drives for this application will not be acceptable. Brackets shall be furnished in cast iron or welded steel construction, designed to withstand all normal operating loads. Where shown on the Drawings floor stands shall be offset type mounted on the floor surface, and offset to align with the gate stem. The floor stand shall be mounted on a heavily ribbed reinforced cast iron or fabricated steel bracket anchored to the concrete with Type 304 stainless steel anchors extending through the concrete to a minimum 1/2-in thick Type 304 stainless steel plate sized to match the bracket. The bracket and anchor bolts shall be sized to transfer the thrust required to ultimately fail the stainless steel stem system. The design and detail of the brackets and anchor bolts shall be provided by the gate manufacturer and acceptable to the Engineer. The bracket, anchors, backplate and accessories shall be supplied as part of the gate assembly by the gate manufacturer.

2. Crank operators shall have either single or double gear reduction depending upon the lifting capacity required. Each type shall be provided with a threaded cast bronze lift nut to engage the operating stem. Bearings shall be provided above and below a flange on the operating nut to support both opening and closing thrusts. Operators shall be designed for a maximum crank effort of 40 pounds (18 kilograms) under the specified operating conditions. Gears, where required, shall be steel with machined cut teeth designed for smooth operation. The stainless steel pinion shafts on crank-operated floorstands, either single or double ratio, shall be supported on tapered roller bearings and enclosed in a cast iron or fabricated steel case and cover. Positive mechanical seals shall be provided on the operating nut and the pinion shafts to exclude moisture and dirt and prevent leakage of lubricant out of the hoist. Lubricating fittings shall be provided for the lubrication of all gears and bearings.

3. The crank shall be of cast iron with a revolving brass grip. The crank shall be removable. Operators shall be equipped with minimum 18 gauge galvanized metal stem cover and dial type position indicator. The top of the stem cover shall be closed. An arrow with the word "OPEN" shall be permanently attached or cast onto the operator to indicate the direction of rotation to open the gate.

4. The pinion shaft of all crank-operated floorstands shall be compatible with portable sluice gate operators such as manufactured by Rodney Hunt, Orange, MA; Waterman Industries, Exeter, CA; Hydrogate, Commerce City, CO or approved equal.

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2.04 STAINLESS STEEL SLUICE GATES

A. The gates shall be conventional type, rising stem unless otherwise noted, fabricated of stainless steel, and shall be designed to have adequate strength to prevent distortion in handling and placing and under any condition of service outlined herein. All metal used in the fabrication of these gates shall be Type 304 or 316 stainless steel. Floor stands shall be ASTM A36 steel or stainless steel. Sluice gates shall be mounted to an embedded wall thimble and the slide shall be supported by guide rails during operation. Each sluice gate actuator and stem shall be supported by a floor stand mounted to a concrete deck above the sluice gate location. Leakage shall be below that allowed by AWWA C501 for cast iron sluice gates.

B. Provide a certification that a professional civil engineer experienced in sluice gate design has prepared calculations to size components and anchorage in accordance with the design criteria is the sluice gate schedule herein and in general sluice gate engineering practice. Include the name, address, and engineering license number with this certification.

C. Guide rails shall be constructed of formed stainless steel plate with a minimum thickness of 1/4-in. Frame design shall be suitable for mounting to a wall thimble. A rigid stainless steel invert weldment shall be provided across the bottom of the frame.

D. The disc or sliding member shall be fabricated of stainless steel plate reinforced with structural members welded to the plate. The disc shall not deflect more than 1/1000 of the span of the gate under the design operating head conditions. A neoprene seal shall be attached to the bottom of the slide and shall be held in place with stainless steel retainers. The slide gate assembly shall be fitted with EPDM or Viton "A" invert, side, and top seals.

E. Adjustable wedge bars shall be provided across the top and sides of the opening to maintain seal compression. Wedge bars shall have seat facings of ultra high molecular weight polyethylene attached with stainless steel fasteners. The wedge bar locking bolt shall hold the wedge bar firmly against the web of the guide frame. Each sluice gate shall be provided with intermediate top stainless steel wedges with ultra high molecular weight polyethylene faces and shall be fully adjustable.

F. Each stem shall be of stainless steel, ASTM A276, Type 304, for the entire length, the metal having a tensile strength of not less than 60,000 psi. The stem shall have sufficient diameter at the base of the thread to lift the weight of the gate, offset the resistance of the gate to the maximum unbalanced head, and fully allow for starting impact. The stem shall be designed to transmit in compression at least 2 times the rated output of the crank operated floor stand with a 40 lb effort on the crank and 1.25 times the stall thrust of the electric operator.

G. Stem guides shall be supplied to support each stem. Stem guides shall be stainless steel with ultra high molecular weight polymer bushings. Bushings shall be adjustable. Stem guide spacing shall not exceed 10-ft and the L/R ratio shall not exceed 200.

H. Stainless steel wall thimbles shall be provided by the sluice gate manufacturer and shall be suitable for the gates supplied, suitable for casting into the concrete mounting walls, and in accordance with the Drawings. The thimble depth shall be equal to the thickness of the concrete wall in which the thimble is to be located. Front flange of thimble shall be

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machined to a true surface and accurately drilled and tapped as required. A water stop of at least 2-in depth shall be provided around the periphery of the thimble.

I. Finish on stainless steel shall be mill finish unless machining is required. Fabricated ASTM A36 steel floor stands shall be coated per Section 09 91 10.

2.05 SURFACE PREPARATION AND PAINTING

A. All ferrous surfaces shall be shop coated as specified in Section 09901.

PART 3 EXECUTION

3.01 INSTALLATION

A. Installation of all items shall be done by the Contractor in an accurate, undamaged, plumb and level, and secure manner. It shall be the responsibility of the Contractor to handle, store and install the equipment specified in this Section in strict accordance with the manufacturer's drawings and recommendations. Frames and guides shall be installed in a true vertical plane and shall be installed with 90 degree corners.

B. Sluice gates and stop logs with embedded guides and/or inverts shall be installed in accordance with the recommendations of the manufacturer subject to the Engineer's approval.

C. The installation of at least the first two of each type of sluice gate shall be under the supervision of a representative of the manufacturer furnishing the sluice gates.

3.02 FIELD QUALITY CONTROL

A. The Contractor shall furnish the services of a factory representative who has complete knowledge of proper operation and maintenance to inspect and approve the final installation and supervise initial adjustments and a test of the equipment, as shown in the Table at the end of this Section.

B. After installation approval, equipment under this Section shall be field tested at maximum differential head to ensure that all items of equipment are in compliance with the Specifications, including the leakage requirements, noted in PART 2.

C. In the event that any product fails to meet the above requirements, the necessary changes shall be made and the unit retested. If the unit remains unable to meet the test requirements to the satisfaction of the Engineer, it shall be removed and replaced with a satisfactory unit at no additional cost to the Owner.

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TABLE OF MANUFACTURERS' REPRESENTATIVE DUTIES

| Services Provided by Factory Representative | Minimum No. Trips (see Note A) | Minimum Time on Site (see Note A) (8 hr. working days) |
|---|---|---|
| 1. Supervise Installation of Sluice Gates | 1 | 1 day |
| 2. Inspect and Approve Installation of Sluice Gates | 1 | 1 day |
| 3. Supervise Initial Adjustment of Sluice Gates | (with Item 2) | |
| 4. Supervise Testing of Sluice Gates | 1 | 1 day |
| 5. Training of District and Engineer Representatives in Proper Sluice Gate Startup and O&M (see Note B) | (Note B) | (Note B) |

Note A: The manufacturer's factory representative shall be present at frequent enough intervals to ensure proper installation testing and initial operation of the equipment.

Note B: This instruction may be given following completion of Items 2 and 4, provided that the testing is successful. Training shall comply with Section 01730.

END OF SECTION

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SECTION 11314

PROGRESSIVE CAVITY PUMP

PART 1 GENERAL

1.01 SCOPE OF WORK

A. Furnish all labor, materials, equipment and incidentals required and install a progressive cavity pump as shown on the Drawings and as specified herein.

1.02. RELATED WORK

A. Training Requirements are included in Section 01730.

B. Operating and Maintenance Data is included in Section 01730.

C. Field painting is included in Section 09902.

D. Sludge Pumps are included in Section 11310

E. Basic Mechanical Materials and Methods are included in Division 01.

F. Motors are included in Section 01171.

G. Control Panels are included in Section 01179.

H. Variable Frequency Drives are included in Division 16.

I. Dewatering Centrifuge system is included in Sections 11363. Centrifuge master control panel is included in Paragraph 2.10.

J. Process Mechanical and Instrumentation Diagrams (PM&IDs).

1.03 SUBMITTALS

A. Submit, in accordance with Section 01300, the following:

1. Certified shop and erection drawings showing all important details of construction, dimensions and anchor bolt locations.

2. Descriptive literature, bulletins and/or catalogs of the equipment.

3. Data on the characteristics and performance of the pump. The data shall include guaranteed performance curves, based on actual shop tests of like pumping units, which show that they meet the specified requirements for head, capacity and horsepower. Curves shall be submitted on 8-1/2-in. by 11-in. sheets.

4. Complete data on motors in accordance with Section 01171.

5. Complete master wiring diagrams, elementary or control schematics, including coordination with other electrical control devices.

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6. The total weight of the equipment, including the weights of the larger components.

7. A complete total bill of materials for all equipment.

8. A list of the manufacturer's recommended spare parts with the manufacturer's current price for each item. Include gaskets, etc on the list. List bearing by the bearing manufacturer's numbers only.

9. Complete description of surface preparation and shop prime painting.

B. Operating and Maintenance Data

1. Operating and maintenance instructions shall be furnished to the Engineer as provided for in Section 01730. The instructions shall be prepared specifically for this installation and shall include all cuts, drawings, equipment lists, descriptions, etc, that are required to instruct operating and maintenance personnel unfamiliar with such equipment.

2. A factory representative who has complete knowledge of proper operation and maintenance of the pump shall be provided to instruct representatives of the OWNER on proper operation and maintenance. See Section 01730. Provide training agenda and training materials per Section 01730.

1.04 REFERENCE STANDARDS

A. American National Standard Institute (ANSI)

B. American Bearing Manufacturers Association (ABMA)

C. National Electrical Manufacturers Association (NEMA)

D. American Gear Manufacturers Association (AGMA)

E. Occupational Safety and Health Administration (OSHA)

F. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.05 QUALITY ASSURANCE

A. Should equipment that differs from the specified requirements be offered and determined to be equal to that specified, such equipment shall be acceptable only on the basis that any revisions in the layout and construction of the structures, piping, electrical, and appurtenant equipment, required to accommodate such a substitution shall be made at no additional cost to the OWNER.

B. Pump, drive unit and motor shall be furnished by the pump manufacturer and be factory-mounted on a common base plate of cast iron or fabricated steel.

1.06 SYSTEM DESCRIPTION

A. All of the equipment specified herein is intended to be standard equipment designed for use in pumping alum sludges with intermixed debris (shells, sand, etc). The maximum expected solids concentration is 3 to 5 percent.

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B. Pump shall have a design capacity of 160 gpm at a maximum pressure of 40 psig. Operating pressure will be as low as 7 psi. Maximum pump speed shall be 900 rpm.

C. The pump drive shall consist of a variable speed motor which shall be connected to the pump shaft through V-belts.

D. The pump shall be controlled locally and remotely for start-stop.

E. The pump motor shall be a maximum of 25 Hp.

1.07 MAINTENANCE

A. Tools and Spare Parts

1. One set of all special tools required for normal operation and maintenance shall be provided.

2. The following spare parts shall be provided:

a. One set of packing for each pump.

b. One set of gaskets for each pump.

c. One rotor and one stator.

d. One set of shaft universal joints.

3. Special tools and spare parts shall be furnished in accordance with Section 11310.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Monoflo Inc Industrial

B. Moyno Industrial Products

C. Seepex Inc.

D. Netzch Pumps

2.02 MATERIALS AND EQUIPMENT

A. General

1. The equipment specified herein is intended to be pumping equipment of proven ability as manufactured by a reputable firm having experience in the production of such equipment. The equipment furnished shall be designed, constructed and installed in accordance with the best practices and methods and shall operate satisfactorily when installed as shown on the Drawings.

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2. All parts shall be so designed and proportioned as to have liberal strength and stiffness and to be especially adapted for the work to be done. Ample room and facilities shall be provided for inspection, repairs and adjustment.

3. All necessary foundation bolts, plates, nuts and washers shall be furnished by the equipment manufacturer and shall be of Type 316 stainless steel. Minimum foundation bolt diameter shall be 3/4-in.

4. Brass or stainless steel nameplates giving the name of the manufacturer, the rated capacity, head, speed and any other pertinent data shall be attached to the pump.

5. The manufacturer shall supply motor, factory-mounted to a common base plate with the pump.

6. The nameplate rating of the motor shall not be exceeded, nor shall the motor design service factor be reduced when its pump is operating at any point on its characteristic curve.

7. Pump and pump base shall have suitable provisions to collect leakage and permit it to be drained away.

8. The pump and drive shall conform to the noise limitations specified in Section 11310.

B. Pump

1. Pump shall be heavy duty, positive displacement, single stage, progressive cavity type. The pump body shall be of thick-walled cast iron and shall incorporate two inspection ports 180 degrees apart. The pump shall be cradle mounted to permit the suction port to be rotated to any angle perpendicular to the centerline of the pump. Suction and discharge connections shall be 5 or 6-in, 125 lb ANSI cast iron flanged.

2. The pump rotor shall be machined of high carbon tool steel, hardened to a Rockwell "C" value of 57 to 60 and covered with a heavy layer of hard chrome plate at least 0.01-in thick for abrasion resistance.

3. The rotor shall rotate relative to a one-piece, EPDM rubber stator of approximate 65 Durometer hardness (Shore A) chemically bonded to its steel tube housing. The stator shall be arranged to prevent the pumped material from contacting the bonding or the tube.

4. The rotor shall be joined to the drive shaft by a stainless steel connecting rod and crowned-gear or pin style close couple type, grease-lubricated, sealed universal joints of chrome alloy tool steel of adequate design to transmit the required thrust and torque while allowing the rotor to move through is eccentric path. The gear or pin style joint seals shall be clamped at both outside and inside diameters and recessed within heavy walled steel tubing to prevent damage by rags or other objects.

5. To maximize universal joint and seal life, the connecting rod operating angle shall not exceed 1-1/4 degrees off center. To minimize the moment of the transmitted radial force on the bearings and to minimize overall pump length, the connecting rod shall telescope

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within a hollow drive shaft and shall be attached to the drive shaft in close proximity to the bearings. This point of attachment shall not be more distant from the nearest bearing than the spacing between the two bearings. This method of drive shall minimize the shaft deflection in the stuffing box area.

6. The drive shaft shall be mounted in two ball or tapered roller bearings. The ABMA minimum B-10 life expectancy of the bearings shall be in excess of 100,000 hours at the maximum operating conditions specified herein. Fittings shall be provided for grease lubrication of the bearings.

7. The stuffing box shall be equipped with a ductile iron gland, split teflon lantern ring to permit repacking of the pump without removing the bearings or drive shaft components. Fittings shall be provided for grease lubrication of the packing.

C. Motor

1. Motor shall be inverter duty, vertical, totally enclosed, fan cooled, foot mounted, NEMA Design B, of horsepower and speed as specified above and shall conform to Specification 01171.

2. Provide a factory-installed winding temperature switches with leads terminating in the main conduit box. The winding temperature switches shall be normally closed, bimetallic contacts, one per phase winding.

3. The drive shall use direct connection right angle drive gear motor arrangement. It shall come complete with guard (as necessary) to be in conformance with OSHA.

D. Base

1. The motor, drive and pump shall be mounted on a common base of welded steel or cast iron. Provide grout holes for grouting to the concrete base.

2.02 Control Panel

A. The manufacturer shall provide a NEMA 12 aluminum control panel. The control panel will be located in the Dewatering Building Electrical Room and will house the VFDs. The control panel will be suitable for operation on a single 480V, three phase, 60 Hz power supply. The control panel and all components housed within shall conform to Section 01179 of these Specifications.

B. There shall be two VFDs located in the manufacturer's control panel. The VFDs shall be rated one size larger than the driven motors. VFDs shall conform to Section 16485 of these Specifications.

C. The control panel shall interface with the Master Control Panel provided with the centrifuge packaged system via hardwired signals as shown on PM&IDs. The pumps maybe operated remotely from the Master Control Panel or associated Operator Interface Terminal (OIT). Master control panel requirements is included in Dewatering Centrifuge system is included in Sections 11363, Paragraph 2.10.

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E. Operator Controls

1. Door mounted controls shall be provided for the manufacturer's control panel:

   a. THICKENED SLUDGE PUMP RUNNING red pilot light (one for each pump)

   b. THICKENED SLUDGE PUMP IN REMOTE blue pilot light (one for each pump)

   c. THICKENED SLUDGE PUMP HIGH SUCTION PRESSURE amber pilot light (one for each pump)

   d. THICKENED SLUDGE PUMP HIGH DISCHARGE PRESSURE amber pilot light (one for each pump)

   e. THICKENED SLUDGE PUMP DRY RUN ALARM amber pilot light (one for each pump)

   f. MOTOR HIGH TEMPERATURE amber pilot light (one for each pump)

2. Provisions for the following controls shall be made in the manufacturer's control panel. Signals will originate in a pushbutton station mounted at the motor. Pushbutton stations and associated wiring will be provided by the Electrical Contractor.

   a. Hand / Off / Auto (one for each pump)

   b. Remote Start (one for each pump)

   c. Remote Stop (one for each pump)

E. Inputs

1. The control panel shall have the following inputs:

   a. Remote Start / Stop from the PLC (one for each pump)

   b. Speed request (one for each pump)

   c. Pressure switch high signal (one for each pump)

   d. Pressure switch low signal (one for each pump)

F. Outputs

1. The control panel shall have the following outputs:

   a. Speed feedback (one for each pump)

   b. Run Status (one for each pump)

   c. In Remote Status (one for each pump)

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d. Common Fault Alarm (one for each pump)

2.03 SURFACE PREPARATION AND SHOP PRIME PAINTING

A. All surfaces items to be shop-primed and finish-coated by manufacturer as specified in Section 09901.

PART 3 EXECUTION

3.01 INSTALLATION

A. Installation shall be in strict accordance with the manufacturer's instructions and recommendations in the locations shown on the Drawings. The pump assembly shall be installed under supervision of a representative of the manufacturer supplying the equipment. Installation shall include furnishing the required oil and grease for initial operation. The grades of oil and grease shall be in accordance with the manufacturer's recommendations and shall be acceptable for use in food packaging plants or NSF 61 approved. Anchor bolts shall be set in accordance with the manufacturer's recommendations.

3.02 INSPECTION AND TESTING

A. Furnish the services of a factory representative for a minimum of two days who has complete knowledge of proper operation and maintenance to inspect the final installation and supervise a test run of the equipment.

B. After the pump has been completely installed, the construction Manager, under the direction of the manufacturer's factory representative, shall conduct in the presence of the Engineer, such tests as are necessary to ensure that pump operation and performance conforms to the requirements specified. Supply all electric power necessary to complete the field tests. Pump shall be operated for at least 24 hours prior to test completion.

C. If the pump performance does not meet the specified requirements, corrective measures shall be taken, or pump shall be removed and replaced with pump which satisfies the conditions specified at no additional cost to the Owner.

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SECTION 11315

SECONDARY CLARIFIER SCUM PUMPS

PART 1 GENERAL

1.01 SCOPE OF WORK

A. Furnish all labor, materials, equipment and incidentals to install four submersible scum pumps, SCP-01, and SCP-02, tested and ready for operation and with all accessories as shown on the Drawings and as specified herein.

1.02 RELATED WORK

A. Yard piping is included in Division 2.

B. Concrete work is included in Division 3.

C. Field painting is included in Section 09902.

D. Instrumentation, unless specified herein is included in Division 13.

E. Mechanical piping, valves, pipe hangers and supports are included in the respective Sections of Division 15.

F. Electrical work is included under Division 16.

1.03 SUBMITTALS

A. Submit to the Engineer, in accordance with Section 01300, copies of all materials required to establish compliance with this Section. Submittals shall include at least the following:

1. Certified shop and erection drawings showing all important details of construction, dimensions and anchor bolt locations.

2. Descriptive literature, bulletins and/or catalogs of the equipment.

3. Data on the characteristics and performance of the pumps. Data shall include guaranteed performance curves, based on actual shop tests of duplicate units, which show that they meet the specified requirements for head, capacity, efficiency, allowable NPSH, allowable suction lift and horsepower. Curves shall be submitted on 8-1/2-in by 11-in sheets.

4. The total weight of the equipment including weight of the single largest item.

5. A complete total bill of materials for all equipment.

6. A list of the manufacturer's recommended spare parts with the manufacturer's current price for each item. Include gaskets, packing, etc, on the list. List bearings by the bearing manufacturer's numbers only.

7. All information required by Section 01170.

8. A statement indicating bearing life.

9. Complete data on motors and power factor correction capacitors (if required) in accordance with Section 01171.

10. Complete description of surface preparation and shop prime painting.

B. Operation and Maintenance Data

1. Copies of an operating and maintenance manual for each size pump shall be furnished to the Engineer as provided for in Section 01170. The manuals shall be prepared specifically for this installation and shall include all required cuts, drawings, equipment lists, descriptions, etc. that are required to instruct operating and maintenance personnel unfamiliar with such equipment.

2. A technical representative, from the respective pump manufacturer, who has complete knowledge of proper operation and maintenance, shall be provided for 1 day to instruct representatives of the Owner and the Engineer on proper operation and maintenance. This work may be conducted in conjunction with the inspection of the installation and test run as provided under Paragraph 3.02 below. If there are difficulties in operation of the equipment due to the manufacturer's design or fabrication, additional service shall be provided at no cost to the Owner.

1.04 REFERENCE STANDARDS

A. American National Standard Institute (ANSI)

B. Anti-Friction Bearing Manufacturers Association (AFBMA)

C. National Electrical Manufacturers Association (NEMA)

D. International Electroctechnical Commission (IEC)

E. National Electrical Code (NEC)

F. Factory Mutual (FM)

H. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

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1.05 QUALITY ASSURANCE

A. Multiple pumps of the same type to be furnished under this Section shall be the product of a single manufacturer. The pumps shall be Landia, Inc. Model No. DG-I 80 Submersible Chopper Pump, or pre-approved equal.

B. The rated horsepower of the drive unit shall be such that the unit will not be overloaded nor the service factor reduced when the pump is operated at any point on the pump's capacity curve. If, due to the slope of the pump's performance curve, a drive unit of greater horsepower than specified is required to meet this condition, the pump will be considered for approval only if any and all changes in electrical work, etc, required by such a change will be provided at no additional cost to the Owner and be to the satisfaction of the Engineer.

1.06 SYSTEM DESCRIPTION

A. The equipment included herein is intended to be standard for submersible use in wastewater treatment.

1. Each pump shall be submersible, chopper type, designed to pump secondary clarifier scum and foam without plugging. Pumps shall be capable of chopping and conditioning of solids such as secondary scum, plastics, heavy rags, grease, and paper products without clogging as part of the pumping action.

B. The submersible pumps shall be as follows:

1. Name: Scum Pumps (SPC-01, SPC-02)

| | |
|---|---|
| a. Location: | Secondary Clarifier No. 3 |
| b. Number of Units: | 2 |
| c. Configuration: | Duplex |
| d. Primary Operating Capacity and Head: | 300 gpm, 40 feet TH |
| e. Minimum Pump Shutoff Head at Design Speed: | 65 feet |
| f. Runout Capacity Max Head: | 20 feet |
| g. Pump Speed at Design Capacity (Max): | 1800 rpm |
| h. Minimum Solids Size: | 1-inch diameter |
| i. Type of Drive: | Constant Speed |
| j. Motor Hp: | 9.0 |

k. Motor Type: Induction

l. Pump Discharge Size: 3-inch

3. These pumps will be used to pump secondary clarifier scum to the gravity thickeners by connecting to the existing WAS line. The pumps will be operated at constant speed, controlled separately by the water level in the chamber. The motors shall be submersible squirrel cage induction type.

1.07 MAINTENANCE

A. One set of all special tools required for normal operation and maintenance shall be provided as specified in Section 01170.

B. Furnish one set of the following spare parts:

1. One set of o-rings

2. One complete cutting system, including all rotating and stationary members. This shall include a spare impeller, if the impeller participates in the chopping.

3. One touch-up epoxy paint kit

4. One set of any special or proprietary mechanical seals that are not readily available from a recognized mechanical seal supplier.

C. All tools and spare parts shall be furnished in accordance with Section 01170.

PART 2 PRODUCTS

2.01 MATERIALS AND EQUIPMENT

A. General

1. This Section is intended to give a general description of what is required, but does not cover all details which will vary in accordance with the requirements of the equipment as offered. It is, however, intended to cover all materials, equipment and appurtenances for the complete pumping units as herein specified, whether specifically mentioned in this Section or not.

2. For all units there shall be furnished and installed all necessary and desirable accessory equipment and auxiliaries whether specifically mentioned in this Section or not and as required for an installation incorporating the highest standards for the type of service.

3. Pump bases or base elbows as the case may be shall be rigidly and accurately anchored into position on concrete and all necessary foundation bolts, plates, nuts and washers shall be furnished and installed. Anchor bolts shall be Type 316 stainless steel.

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4. Brass or stainless steel nameplates giving the name of manufacturer, the rated capacity, head, speed and all other pertinent data shall be attached to each pump and each motor.

5. The manufacturer shall supply complete factory mounted equipment with sufficient power and signal cable, as required by the location.

7. All electrical materials and equipment shall be UL listed or FM approved and NEMA or IEC rated, and shall otherwise be equal to that supplied under Division 16, where applicable.

8. Control panels shall be factory wired, such that field wiring connections shall require connection of power and control/sensory wiring to the control panel and to the pumps and alarm wiring to the control panel and the pump failure alarm light. Field wiring connections shall be to numbered terminal strips. The entire control system shall be factory tested before shipment.

## 2.02 PUMP CONSTRUCTION

### A. Casing

1. Casing shall be of gray cast iron AISI A48-40B with all water passages to be smooth, and free of blowholes and imperfections that inhibit good flow characteristics. Fabricated casings will not be accepted.

2. Front and back suction plates shall be machined such that all solids are directed away from the seal area. In addition, back pump out vanes on the impeller shall eliminate debris from collecting around the seal area.

3. An anti-clog bar shall be mounted on the pump volute in conjunction with the stationary knives. The impeller shall incorporate a raised van tip, which, in conjunction with the anti-clog bar, will eliminate stringy material from clogging the impeller eye. Pump designs that require a cleanout plug in the pump casing shall not be accepted.

### B. Pump Assembly

1. All mating surfaces where watertight sealing is required shall be machined and fitted with Nitrile rubber O-rings. Fitting shall be such that sealing is accomplished by metal-to-metal contact between machined surfaces, resulting in compression of the O-rings without requiring specific torque limit. No secondary sealing compounds, rectangular gaskets, elliptical O-rings, grease, or other devices shall be used.

### C. Chopping System

1. Chopping/maceration of solids shall be accomplished by the action of two rotating knives moving across one stationary knife or alternatively three stationary knives mounted by the pump inlet external of the pump casing. The chopping system shall be designed to prevent the pump inlet from clogging and require no adjustment for optimal functionality

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2. Rotating and stationary knives shall be easily replaceable without the use of special tools or requirement of pump disassembly.

3. Stationary and rotating knives shall be of steel AISI A570 Gr.36 and heat treated to 60 Rockwell C Hardness.

D. Impeller

1. Impeller shall be open type cast iron AISI A48-40B and dynamically balanced. The impeller shall be rigidly held in place with an impeller bolt and have no axial adjustments and no set screws. Fabricated impellers will not be acceptable.

2. The impeller shall not be required to assist in any chopping/macerating function. Pump designs that require the impeller to chop solids shall not be accepted.

E. Submersible Electric Motor

1. The pump motor shall be submersible of the asynchronous speed type, housed in an air-filled, watertight chamber and shall be U/L listed explosion proof for Class I, Group D, Division 1 hazardous locations, rated at 9.0 HP, 1800 RPM, 460 Volts, 60 Hertz and 3 phase. The motor shall meet the standards of IEC class N. The stator winding shall be insulated with moisture resistant Class F insulation, which shall resist temperatures of 315°F. The stator shall be dipped and baked three times in Class F varnish. The motor shall be designed for continuous-duty, capable of sustaining a maximum of 10 evenly spaced starts per hour. The rotor bars and short circuit rings shall be made of aluminum. The motor shaft, delivered with the rotor as an integral part, shall be shafting steel AISI 4340. The stator housing shall be of gray cast iron AISI A48-40B.

2. The thermal sensors, embedded in the stator winding and wired into the mixer control, shall monitor over temperature. These shall supplement the external motor over current protection located in the control panel.

F. Cable Entry

1. The cable entry shall be an integral part of the stator casing. The cable entry shall be composed of a conical cable holder with a flange bearing against a shoulder in the stator casing opening. The cable entry cone shall be of gray cast iron AISI A48-40B. Sealing shall be accomplished by metal-to-metal contact between machined surfaces resulting in compression of the O-ring. The cable shall be cast into the cable entry cone providing a leak-proof, torque-free seal at the cable entrance. No terminal board in the motor shall be required.

G. Seals

1. Each pump shall be provided with a double mechanical seal system, each containing one stationary silicon carbide ring and one rotating silicon carbide part running in the oil for cooling and lubrication. They shall be mounted on the motor shaft to isolate the oil chamber from the dry motor stator housing and the medium from the oil chamber. The

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outer mechanical seal shall be protected by the impeller and pump casing back plate design, both having pump out vanes to reduce seal area pressure and to prevent any build-up of solids between impeller and pump casing.

2. Each pump shall be provided with an oil chamber for the shaft sealing system. Drains and inspection plugs shall be provided with positive anti-leak seal and shall be accessible from the outside.

3. Mechanical seals shall not require a lubrication monitoring system to ensure reliability.

4. As a supplement to the sealing system, a moisture sensor shall be installed in the oil chamber. Used in conjunction with a seal monitor relay, the system shall monitor and detect the presence of water in the oil chamber. An alarm condition shall be initiated when the percentage of water in the oil reaches a preset alarm threshold.

H. Shaft and bearings

1. The pump motor shaft shall rotate on two permanently lubricated bearings. The inner and outer bearing shall be single row, deep-groove ball bearings calculated for an L-10 life of 100,000 hours at full load.

2. The motor shaft shall be Alloy Steel AISI 4340.

3. The impeller shall be mounted directly on the motor shaft. No shaft coupling shall be required.

I. Guide Rail and Discharge System

1. Provide a guide rail and discharge system for each pump consisting of the following:

a) one stainless steel guide rail

b) ductile iron pump guide bracket

c) discharge elbow with mounting feet and 150 lb. flange

d) an upper guide rail mounting bracket.

J. Surface Preparation

1. SSPC-SP5 white metal sandblast.

2. Finish coat all surfaces with 8 MDFT of 2-component epoxy paint.

2.03 PUMP CONTROLS

A. Provide an automatic pump control system as follows.

1. The control system shall utilize liquid level sensors to operate at preset liquid levels in the pump well to control the pumps. Level controls shall be set to perform the following functions:

a. Switch No. 1(LSSL): Redundant low level cut out and alarm

b. Switch No. 2(LSL): Pump Stop

c. Switch No. 3(LSH): Pump Start

d. Switch No. 4(LSSH): HWL Alarm

e. The sensors shall be supplied by the pump manufacturer, rated for operation at milliwatt levels and be set at the elevations shown on the Drawings. Provisions shall be made to prevent tangling of the level sensor cables at all water levels in the wet well. Provide sufficient excess cable to permit field adjustment.

2. A complete control panel shall be provided for mounting and shall be completely wired and ready for field connection of power, control/sensory and alarm wiring. Control panel shall be equipped with all items required for a complete and operational unit, including timer, motor starter, hand/off/ automatic switch. The control panel shall be of NEMA 4 stainless steel designed for outdoor mounting. The panel shall be mounted in the location shown on the Drawings.

   a. Local control panel shall provide lamps for motor run signals, and faults.

   b. Hand-Off-Auto switches for motors shall be provided.

   c. Dry contacts shall be made available for signals being fed to the SCADA system. See Instrumentation Drawings and I/O list in Division 13.

3. Power supply to the control panel will be 460 Volt, 3 Phase, 60 Hz, 3 Wire. For each pump motor provide an individual thermal magnetic circuit breaker/disconnect switch interlocked with the door handle, three phase overload protection with manual reset, and a magnetic motor starter with NEMA Class 10 overload relays. Control design shall provide for automatic and manual operation. Level switches and control shall be UL approved as intrinsically safe. Control leads to and from the wet well shall be low voltage, microwatt type designed such that if system components fail, voltage and current will not exceed their normal values. All of the low voltage intrinsically safe components shall be isolated by and mounted through a grounded metal barrier. All field connections shall be by means of terminals. Panel shall have Hand/Off/Automatic selector switch, pump run light, pump running time meter, a thermostatically (adjustable) controlled condensate heater and lightning protection. Provide panel mounted lights for indication of each of the following: Low Water Level, High Water Level, High Motor Temperature, and Motor Moisture. Provide a common contact for a panel powered external alarm.

## 2.04 ACCESSORIES AND APPURTENANCES

A. Pump accessories and appurtenances shall include, but not be limited to:

1. Power and control/sensory holder.

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2. Lifting chains (all pumps).

3. Safety chain hooks.

4. Guide rails.

5. Upper guide bar brackets.

B. Chain, safety chain hooks and cable holder shall be stainless steel. Chain hooks and cable holder shall be positioned on the access hatch cover frame in or concrete, as applicable. Cable holder may be galvanized steel.

C. Provide upper guide bar brackets on the concrete wall to support the pump guide bars.

D. Provide structural steel support for the check valves as shown on the Drawings. Expansion bolts shall be Type 316 stainless steel, Hilti "Kwik Bolt" or equal. All other bolts, nuts and washers shall be of Type 316 stainless steel. Field paint steel support with Tnemec, Series 66 Epoxy Primer and finish coat, or equal surface preparation.

E. All exposed metal within the wet well, except stainless steel or unless otherwise specified herein shall be primed and finish painted to meet manufacturer's recommendations.

## PART 3 EXECUTION

### 3.01 INSTALLATION

A. Installation shall be in strict accordance with the manufacturer's instructions and recommendations in the locations shown on the Drawings. Installation shall include furnishing the required oil and grease for initial operation. The grades of oil and grease shall be in accordance with the manufacturer's recommendations. Anchor bolts shall be set in accordance with the manufacturer's recommendations.

### 3.02 INSPECTION AND TESTING

A. Factory Test

1. The pump manufacturer shall perform the following inspections and tests on each pump before shipment from the factory:

   a. A balancing of the motor (rotor).

   b. A dry run pump test to verify correct rotation and mechanical integrity. The entire unit is checked for vibration.

   c. A Full Load Motor Test (run dry for 5 minutes at full load) to verify electrical data measurements. All electrical data shall be registered as part of documentation.

   d. A submerged test of the pump where pump casing is exposed to an over pressure of 15 PSI.

e. A motor and cable insulation test for moisture content and insulation defects.

2. Controls shall be factory tested and documentation of the test shall be submitted.

3. No equipment shall be shipped until all of the above test results are received.

B. After all pumps have been completely installed, conduct in the presence of the Engineer, and plant operator such tests as are necessary to indicate that pump efficiency and discharge conform requirements specified. Field tests shall be performed on all pumps furnished under this Section. Supply all electric power, labor and water or wastewater and auxiliary equipment required to complete the field tests.

C. If the pump performance does not meet the specified requirements, corrective measures shall be taken, or pumps shall be removed and replaced with pumps with satisfy the conditions specified. A 24 hour operating period of the pumps will be required before acceptance. During this 24 hour operating period, supply all power necessary.

D. The pumps and motors shall be designed and constructed to avoid the generation of objectionable noise or vibration. The sound pressure level at full load shall not exceed 90 (A Scale) decibels above 300 cycles, when measured at a point not exceeding 5-ft from the motor. Mufflers or external baffles will not be accepted. When operating at any point between no-load and full-load, the vibration measured in a horizontal plane at the top of the motor shall not exceed the limits recommended by the Hydraulic Institute Standards.

E. Any component parts which are damaged as a result of testing or which fail to meet the requirements specified shall be replaced, reinstalled and retested at the Contractor's expense.

END OF SECTION

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SECTION 11316

SUMP PUMPS

PART 1 GENERAL

1.01 SCOPE OF WORK

A. Furnish all labor, materials, equipment and incidentals to install, test, complete, and make ready for operation, a submersible sump pump system for the drainage from the RAS/WAS pump station shown on the Drawings and as specified herein. The submersible sump pump station shall be provided with a control panel and mercury tip floats as specified herein.

B. Furnish and install necessary and desirable accessory equipment and auxiliaries, whether specifically mentioned in this specification or not, as required for an installation incorporating the highest standards for the type of service.

1.02 RELATED WORK

A. Concrete work is included in Division 3.

B. Field painting is included in Division 9.

C. Instrumentation, unless specified herein is included in Division 13.

D. Pump control panels are included in Division 13.

E. Mechanical piping, valves, pipe hangers and supports are included in the respective Sections of Division 15.

F. Electrical work is included under Division 16.

1.03 SUBMITTALS

A. Copies of all materials required to establish compliance with the specifications shall be submitted in accordance with the provisions of Section 01300. Submittals shall include at least the following:

1. Certified shop and erection drawings showing important details of construction, dimensions.

2. Descriptive literature, bulletins and/or catalogs of the equipment.

3. Data on the characteristics and performance of the pumps. Data shall include certified performance curves, based on actual shop tests of duplicate units, which show that they meet the specified requirements for head, capacity, efficiency, allowable NPSH, allowable suction lift and horsepower. Curves shall be submitted on 8-1/2-in by 11-in sheets.

4. The total weight of the equipment including weight of the single largest item.

5. A complete total bill of materials for all equipment.

6. A list of the manufacturer's recommended spare parts with the manufacturer's current price for each item. Include gaskets, packing, etc, on the list. List bearings by the bearing manufacturer's numbers only.

7. A statement indicating bearing life.

8. Complete description of surface preparation and shop prime painting.

9. Written statement from the Electrical Contractor and from the Systems Integrator that they have reviewed the specifications and controls and have coordinated to provide as required.

B. In the event that it is impossible to conform with certain details of the specifications due to different manufacturing techniques, describe completely all non-conforming aspects.

C. Operation and Maintenance Data

1. Copies of an operating and maintenance instructions shall be furnished to the Engineer as provided for in Section 01730. The instructions shall be prepared specifically for this installation and shall include all required cuts, drawings, equipment lists, descriptions, etc. that are required to instruct operating and maintenance personnel unfamiliar with such equipment.

2. A technical representative from the respective pump manufacturer who has complete knowledge of proper operation and maintenance shall be provided for one day to instruct representatives of the Owner and the Engineer on proper operation and maintenance. This work may be conducted in conjunction with the inspection of the installation and test run as provided under Paragraph 3.02. If there are difficulties in operation of the equipment due to the manufacturer's design or fabrication, additional service shall be provided at no cost to the Owner.

1.04 REFERENCE STANDARDS

A. American National Standard Institute (ANSI)

B. Anti-Friction Bearing Manufacturers Association (AFBMA)

C. National Electrical Manufacturers Association (NEMA)

D. National Electrical Code (NEC)

E. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.05 QUALITY ASSURANCE

A. The pumps covered by these Specifications are intended to be standard pumping equipment, as modified by these Specifications, of proven ability, as manufactured by a single manufacturer, having long experience in the production of such pumps. The pumps furnished

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shall be designed, constructed and installed in accordance with the best practices and methods and shall operate satisfactorily when installed as shown on the Drawings and specified herein. Pumps shall be manufactured in accordance with the standards of the Hydraulic Institute.

B. Should equipment which differs from these Specifications be offered and determined to be equal to that specified, such equipment shall be acceptable only on the basis that any revisions in the design and/or construction of the structure, piping, appurtenant equipment, electrical work, etc. required to accommodate such a substitution shall be made at no cost to the owner and be as approved by the Engineer.

C. The rated horsepower of the drive unit shall be such that the unit will not be overloaded nor the service factor reduced when the pump is operated at any point on the pump's capacity curve. If, due to the slope of the pump's performance curve, a drive unit of greater horsepower than specified is required to meet this condition, the pump will be considered for approval only if any and all changes in electrical work, etc, required by such a change will be provided at no additional cost to the Owner and be to the satisfaction of the Engineer.

D. For the set of pumps, the two pumps shall be identical.

1.06 SYSTEM DESCRIPTION

A. Two sump pumps shall be installed in the sump area of the new RAS/WAS pump station as shown on the drawings. The pumps shall be used for pumping liquid from the RAS/WAS pump station as shown on the drawings. The pumps shall be wet pit type sump pumps with all materials in contact with the pumped fluid.

B. Two sump pumps shall be installed in the sump area of the existing RAS/WAS pump station as shown on the drawings. The pumps shall be used for pumping liquid from the RAS/WAS pump station as shown on the drawings. The pumps shall be wet pit type sump pumps with all materials in contact with the pumped fluid.

1.07 MAINTENANCE

A. One set of all special tools required for normal operation and maintenance shall be provided as specified in Section 01730.

B. The following spare parts shall be provided:

1. One extra set of mechanical seals for each pump system.

2. Two complete sets of gaskets, "O"-rings, etc for each pump system.

1.08 WARRANTY

A. The manufacturer shall guarantee that equipment shall perform in accordance with this Section when operated at the specified design conditions.

B. Provide from the equipment manufacturer an unconditional extended warranty for a period of 12 months after the final acceptance of the equipment by the Owner and furnish to the Owner any items found to be defective within the 1 year period.

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PART 2 PRODUCTS

2.01 MATERIALS AND EQUIPMENT

A. General

1. Stainless steel nameplates giving the name of manufacturer, the rated capacity, head, speed and all other pertinent data shall be attached to each pump and each motor.

2. The manufacturer shall supply complete factory mounted equipment with sufficient power and signal cable, as required by the location.

3. Each pump and drive shall be designed to withstand the maximum turbining run-away speed of the pump due to backflow through the pump.

4. All electrical materials and equipment shall be Underwriters Laboratories Inc. listed or Factory Mutual approved and NEMA rated, and shall otherwise be equal to that supplied under Division 16, where applicable.

5. Control panels as applicable shall be wired, such that field wiring connections shall require connection of power and control/sensory wiring to the control panel and to the pumps and alarm wiring to the control panel and the pump failure alarm light. Field wiring connections shall be to numbered terminal strips. The entire control system shall be factory tested before shipment. Control panels shall comply with all requirements of Section 13330.

B. Sump Pumps

1. Location: New RAS/WAS Pump Station

| | | |
|---|---|---|
| a. | Number of Units: | 2 (1 duty, 1 stand-by) |
| b. | Configuration: | parallel |
| c. | Design point 1 (each pump): | 40 gpm at 40' TDH |
| d. | Pump Speed at Design Capacity (Maximum): | 1550 rpm |
| e. | Solids Handling: | 3/4" dia. |
| f. | Minimum Shut-off Head: | 60 ft |
| g. | Motor data: | 1 HP, 115 volt, single phase |
| h. | Motor Type: | submersible |
| i. | Pump Discharge Size: | 2-in. |
| j. | Pump Tags | SP-01 and SP-02 |

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2. Location: Existing RAS/WAS Pump Station

| | |
|---|---|
| a. Number of Units: | 2 (1 duty, 1 stand-by) |
| b. Configuration: | parallel |
| c. Design point 1 (each pump): | 40 gpm at 40' TDH |
| d. Pump Speed at Design Capacity (Maximum): | 1550 rpm |
| e. Solids Handling: | 3/4" dia. |
| f. Minimum Shut-off Head: | 60 ft |
| g. Motor data: | 1 HP, 115 volt, single phase |
| h. Motor Type: | submersible |
| i. Pump Discharge Size: | 2-in. |
| j. Pump Tags | SP-03 and SP-04 |

The pumps will be operated at constant speed and controlled by the water level in the sump.

The pumps shall be Hydromatic Model HP50 or an engineer approved equal.

2.02 PUMP CONSTRUCTION

A. The pumps shall be totally submersible and be removable by breaking the discharge piping, which shall include a union for that purpose.

B. The stator casing, coil casing and volute shall be constructed of gray iron. All external bolts and nuts shall be of stainless steel. Castings shall be spray painted or dipped in an electrostatic deposition paint system depending on the part size.

C. The impeller shall be fiberglass reinforced Noryl with threaded brass insert. The impeller shall be of a centrifugal vortex, non-clog design, capable of passing ½" solids, fibrous material and heavy sludge, and constructed with long throughway with no acute turns.

D. Each pump shall be provided with a single mechanical seal running in an oil reservoir, composed of two separate lapped seal faces.

E. Pump shafts shall be of corrosion resistant stainless steel, ANSI 431 or equal.

F. Pumps shall be constructed with lower bearings. Lower bushings in lieu of bearings will not be acceptable.

G. Pump and motor bearings shall be anti-friction type with a B-10 life of 20,000 hours minimum.

H. Each pump shall be provided with a lifting handle.

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I. Pump motors shall be housed in an oil-filled watertight submersible casing and shall have Class F insulated windings that shall be moisture resistant. Pump motors shall be 120 volt, single phase, 60 Hz. Motors shall be NEMA Design B. Motor characteristics are specified above. Pump motors shall have cooling characteristics suitable to permit continuous operation, in a totally, partially, or non-submerged condition. The pump motor shall be capable of running without damage for extended periods. Motor shall be provided with pilot thermal sensors embedded in stator windings.

J. Pump power cable shall be suitable for submersible pumps. Cable sizing shall conform to National Electrical Code specifications for pump motors. Cable entry to each pump shall be designed for submersible pump applications. The cable entry junction box and motor shall be separated by a stator load sealing gland or terminal board that shall isolate the motor interior from foreign materials gaining access through the pump top. Provide cable holder as herein specified.

K. The pumps, with their appurtenances and cable, shall be capable of continuous submergence under water without loss of watertight integrity to a depth of 65-ft. The pumps shall receive a factory test to determine that each unit operates satisfactorily and that all seals are properly in place, under the above specified submergence conditions.

## 2.03 PUMP CONTROLS

A The control system shall utilize the float switch assembly provided with the pumps to operate at preset liquid levels in the pump well to control the pumps. An independent float switch shall be provided for a high wet well alarm. Level controls for each of the pumps shall be set to perform the following functions. Panel shall be UL 508 as supplied by Chase Controls or an engineer approved equal.

**SP-01 & SP-02**

- Pump Stop (EL 311.83)
- Pump Start (EL 312.25)
- HWL Alarm (EL 314.00)

**SP-03 & SP-04**

- Pump Stop (EL 311.5)
- Pump Start (EL 312.1)
- HWL Alarm (EL 314.00)

## 2.04 SURFACE PREPARATION AND PRIME PAINTING

A. All equipment furnished under this Section shall be shop primed and finish painted as specified in Section 09902 and herein.

B. All exposed metal within the wet well, except stainless steel or unless otherwise specified herein, shall be primed and finish painted to meet manufacturer's recommendations.

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PART 3 EXECUTION

3.01 INSTALLATION

A. Installation shall be in strict accordance with the manufacturer's instructions and recommendations in the locations shown on the Drawings. Installation shall include furnishing the required oil and grease for initial operation. The grades of oil and grease shall be in accordance with the manufacturer's recommendations.

3.02 COORDINATION WITH ELECTRICAL REQUIREMENTS

A. Unless otherwise specified, the Contractor shall be responsible for furnishing all controls including magnetic starters with overload and under voltage protection, pushbutton stations, timers, limit switches, H-O-A switches, enclosures and other items as required by particular equipment in accordance with the manufacturer's recommendations and as shown on the Drawings.

B. The vendors of the various pieces of equipment shall refer to the electrical specifications and the electrical drawings to supplement this section of the Specifications. Any additional equipment shown on the electrical plans or called for in the electrical specifications not specified in this section shall be furnished by the vendor. The plant electrical system is custom designed to the specific requirements of the Owner using a custom control system. The vendors shall design their electrical equipment and panels to match these electrical requirements. Shop drawings shall be submitted showing external wiring terminals and properly identifying the devices they are to be inter-connected with. Any drawings submitted where it is obvious that no effort was made to properly prepare them for easy checking by the Engineer will be rejected.

C. The electrical contractor shall coordinate with the mechanical contractor and carefully review the mechanical packages proposed to be supplied. It shall be the electrical contractor's responsibility to insure that all wire and conduit needed for electrical appurtenances associated with mechanical packages are provided even if not specifically called for in the plans and specifications.

END OF SECTION

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SECTION 11317

# VERTICAL SOLIDS HANDLING PUMPS MOUNTED IN DRY PIT APPLICATIONS (RAS/WAS Pumps)

## PART 1 GENERAL

### 1.01 SCOPE OF WORK

A. The Contractor shall furnish all labor, materials, equipment and incidentals required and install, place in operation and field test eight (5 RAS Pumps, 3 WAS Pumps) dry pit mounted vertical close coupled wastewater pumps as specified herein and as shown on the Drawings. The equipment to be furnished and installed shall be as shown on the Drawings and shall include pumps, motors and pump accessories, all tested and ready for operation.

B. This Section is intended to give a general description of what is required, but does not cover all details which will vary in accordance with the requirements of the equipment as offered. It is, however, intended to cover the furnishing, the shop testing, the delivery and complete installation and field testing of all materials, equipment and appurtenances for the complete pumping units as herein specified, whether specifically mentioned in this Section or not.

C. All pumps shall be speed controlled by variable frequency drive controllers, which shall be furnished by the Contractor. Variable frequency drive controllers shall conform to the requirements of Section 16482. The Contractor, pump manufacturer and variable frequency drive manufacturer shall be responsible for coordinating the characteristics of the pump motors and the design of the starting and variable speed systems.

### 1.02 RELATED WORK

A. Concrete work is included in Division 3.

B. Field painting is included in Section 09902.

C. Mechanical piping, valves, pipe hangers and supports are included in the respective Sections of Division 15.

D. Electrical work is included under Division 16.

E. Instrumentation work is included under Division 13.

### 1.03 SUBMITTALS

A. Copies of all materials required to establish compliance with the Specifications shall be submitted in accordance with the provisions of the General Conditions and Section 01300. Submittals shall include at least the following:

1. Shop and erection drawings showing all important details of construction, dimensions and anchor bolt locations.

2. Descriptive literature, bulletins, and/or catalogs of the equipment. Sufficient data shall be submitted to document previous production of each pump model proposed for use on this Contract. Data shall include installation and reference list, with contact information, specified under paragraph 1.06 below.

3. Data on the characteristics and performance of each pump. Data shall include guaranteed performance curves, based on actual shop tests of similar units, which show that they meet the specified requirements for head, capacity, efficiency, NPSHR and horsepower. Curves shall be submitted on 8-1/2-inch by 11-inch sheets, at as large a scale as is practical. Curves shall be plotted from zero flow at shut off head to pump capacity at minimum specified TDH. Catalog sheets showing a family of curves will not be acceptable.

4. The total weight of the equipment including the weight of the single largest item.

5. Drawings showing the layout of the pump protection panels. The layout shall show front and side elevations and shall indicate every device mounted on the inner or exterior door and subpanel with complete identification.

6. Complete wiring diagrams and schematics of all power and control systems showing wiring requirements between all system components, motors, sensors, control panels, starters and related systems.

7. A complete total bill of materials of all equipment.

8. A list of the manufacturer's recommended spare parts to be supplied in addition to those specified in Paragraph 1.08, with the manufacturer's current price for each item. Include gaskets, seals, etc. on the list. List bearings by the bearing manufacturer's numbers only.

9. All submittal data required by the General Conditions.

10. Complete motor data, including, but not limited to: type of enclosure design, rated horsepower, rated voltage, FLA, Starting Current, LRA, LR KVA, NEMA Code Letter, rpm, input power in kW at nameplate rating, starting calculations, cable size, efficiency at 50 percent, 75 percent and 100 percent load, and power factor at 50 percent, 75 percent and 100 percent load.

11. Verification of compatibility and coordination with variable frequency drives specified in Division 16.

12. Certified agreement to the conditions of the warranty.

13. Lifting frame shop drawings.

B. In the event that the equipment offered does not conform to all of the detailed requirements of the Specifications, describe completely any nonconforming aspects. Failure to describe any and all deviations from the specifications will be cause for rejection.

C. Operating and Maintenance Manuals: Provide Operating and Maintenance manuals in accordance with the applicable provisions of Section 01730.

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D. Submit to Engineer the Equipment Manufacturer's Certificate of Installation, Testing, and Instruction as specified in Section 01665.

1.04 REFERENCE STANDARDS

A. Design, manufacturing and assembly of elements of the equipment herein specified shall be in accordance with, but not limited to, published standards of the following, as applicable:

1. American Gear Manufacturers Association (AGMA)
2. American Institute of Steel Construction (AISC)
3. American Iron and Steel Institute (AISI)
4. American Society of Mechanical Engineers (ASME)
5. American National Standards Institute (ANSI)
6. American Society for Testing Materials (ASTM)
7. American Welding Society (AWS)
8. American Bearing Manufacturers Association (ABMA)
9. Hydraulic Institute Standards (current edition)
10. Institute of Electrical and Electronics Engineers (IEEE)
11. National Electric Code (NEC)
12. National Electrical Manufacturers Association (NEMA)
13. Occupational Safety and Health Administration (OSHA)
14. The Society for Protective Coatings (SSPC)
15. Underwriters Laboratories, Inc. (UL)
16. Factory Mutual (FM)
17. National Fire Protection Association (NFPA)

B. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.05 DESCRIPTION OF SYSTEM

A. The eight dry pit mounted vertical close coupled pumping units will each be connected by suction piping routed from a secondary clarifier.

B. Each pumping unit will start, change speeds and stop in accordance with a pre set pump control program as shown on the Instrumentation Drawings and specified in Division 13 herein.

C. Three of the units (two duty, one stand-by) shall provide pumping for delivery of return activated sludge (RAS) from Secondary Clarfiers No.1 and No. 2 to the aeration basin distribution structure or the existing secondary clarifier RAS piping. Two of the units (one duty, one stand-by) shall provide delivery of waste activated sludge (WAS) to the existing aerobic digesters via the existing 6-inch WAS line.

D. Minimum normal pump speed of the RAS pumps will be approximately 60 percent of pump design speed and the pumping rate for each pump will vary from approximately 600 to 1689 gpm through the normal operating range. The minimum normal pump speed of the WAS pumps will be approximately 70 percent of the pump design speed and the pumping rate will vary from approximately 120 to 450 gpm through the normal operating range.

E. Two of the units (one duty, one stand-by) shall provide pumping for delivery of return activated sludge (RAS) from Secondary Clarifier No. 3 to the aeration basin distribution structure or to the raw sewage pump station. One of the units (one duty) shall provide delivery of waste activated sludge (WAS) to the existing aerobic digesters via a new 6-inch WAS line.

F. Minimum normal pump speed of the RAS pumps will be approximately 60 percent of pump design speed and the pumping rate for each pump will vary from approximately 600 to 1689 gpm through the normal operating range. The minimum normal pump speed of the WAS pumps will be approximately 70 percent of the pump design speed and the pumping rate will vary from approximately 120 to 450 gpm through the normal operating range.

1.06 QUALIFICATIONS

A. To assure unity of responsibility, the pumps, motors, pump monitor system, and other auxiliary equipment, and materials specified in this Section shall be furnished and coordinated by the pump manufacturer who, along with the Contractor, shall assume responsibility for the satisfactory operation of the entire pumping system including pumps, motors, controls, and accessories.

B. The pumps and other equipment covered by this Section shall be standard production units of the manufacturers, currently available and listed in the respective manufacturer's catalog. The pumps furnished shall be in accordance with the Hydraulic Institute Standards, except as modified herein under and shall be designed, constructed and installed in accordance with the best practice and methods, and shall operate satisfactorily when installed.

C. The pump manufacturer shall have an authorized warranty center within a 500 mile radius of the job site, fully staffed with factory trained mechanics, and equipped with a stock of all reasonably anticipated spare parts for each model of pump furnished under this contract. The service facility shall be an established entity prior to delivery of equipment for this project, completely equipped with spare parts and crane equipped trucks. The service facility shall also be capable of providing a 48-hour turnaround time on any pumps brought in for repair. The warranty center shall maintain an inventory of original factory replacement parts,

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including but not limited to, mechanical seals, bearings, O-rings, stators, impellers and wear rings.

D. All equipment furnished under this Section shall be new and unused, shall be the standard product of manufacturers having a successful record of manufacturing and servicing the equipment and systems specified herein for a minimum of five years. The Manufacturer shall be able to demonstrate, by the submittal of data, including reference contact information, at least 5 successful installations of the same size pumps over the last 10 years.

E. The pump manufacturer shall be fully responsible for the design, arrangement, and operation of all connected rotating components of the assembled pumping unit mounted on a fabricated concrete/steel support system, to ensure that neither harmful nor damaging vibrations occur at any speed within the maximum potential operating range of 40 to 100 percent speed.

F. The manufacturer shall provide lateral and torsional critical speed analyses to identify and ensure that (a) the first lateral critical speed shall be at least 25 percent above the maximum pump speed, (b) that the first torsional critical speed is at least 25 percent above the maximum pump speed, and (c) that 1x frequencies or impeller blade-pass frequencies within the pump speed range shall be no closer than plus or minus 25 percent of the natural frequency of the installed pumping unit.

G. Vibration, when measured in the direction of maximum amplitude at the top motor bearing, shall not exceed the limitations established by the Hydraulic Institute Standards at any speed within the specified operating speed range.

1.07 OPERATING INSTRUCTIONS

A. A factory representative who has complete knowledge of proper operation and maintenance shall be provided for a minimum of two 8-hour working days total to instruct representatives of the Owner and the Engineer in proper operation and maintenance of the equipment with both dedicated classroom training and dedicated hands-on training prior to the initial start-up of the respective system/equipment. This training shall be provided twice, in four, 4-hour sessions on the multiple days to facilitate operator work schedules.

B. The acceptance of this training will be in accordance to the successful completion of the Vendor Training Review Checklist as provided in Section 01730. This checklist will be completed by the Owner and Engineer at the completion of each vendor training session.

C. This instruction period shall be scheduled at least 14 working days in advance with the Owner and shall take place prior to start-up and acceptance by the Owner. The preliminary copies of Operation and Maintenance manuals specified in Section 01730 must have been approved by the Engineer and delivered to the Owner prior to scheduling the instruction period with the Owner.

D. Start-Up: One day of O&M hands-on training and system optimization shall be provided to the Owner and Engineer on the day of system/equipment start-up and on-line operation.

E. This work may be conducted during the same trip as the inspection of installation and test run as provided under PART 3, unless otherwise specified. If there are difficulties in operation of

the equipment due to the manufacturer's design or fabrication, additional service shall be provided at no additional cost to the Owner.

1.08 TOOLS AND SPARE PARTS

A. One set of all special tools required for normal maintenance shall be provided by the manufacturer. All such tools shall be furnished in a suitable steel tool chest complete with lock and duplicate keys.

B. The manufacturer shall furnish a complete list of recommended spare parts necessary for the first five years of operation for each pump model.

C. The pump manufacturer shall have a guaranteed parts stock program, at a distribution center within 500 miles of the job site. The guaranteed stock shall include at least three sets of spare parts, as listed below, for each pump model and size supplied under this Contract. As a part of the shop drawing submittal, the manufacturer shall furnish a notarized statement that the parts are in stock and available for inspection by the Engineer.

Furnish spare parts as listed below:

1. One Split seal per pump.
2. Wear Rings
3. One Gasket set per Pump
4. Inspection plugs and washers
5. Impeller bolts and keys
6. Upper and lower bearing

D. All spare parts shall be properly protected for long periods of storage and packed in containers which are clearly identified with indelible markings as to the contents.

1.09 PRODUCT HANDLING

A. All equipment and parts shall be properly protected so that no damage or deterioration will occur during a prolonged delay from the time of fabrication until final delivery to the job site.

B. Factory assembled parts and components shall not be dismantled for shipment unless permission is received in writing from the Engineer.

C. Finished surfaces of all exposed pump openings shall be protected by wooden blanks, strongly built and securely bolted thereto or by other approved means.

D. Finished iron or steel surfaces not painted shall be properly protected to prevent rust and corrosion.

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E. After hydrostatic or other tests, all entrapped water shall be drained prior to shipment and proper care shall be taken to protect parts from the entrance of water during shipment, storage and handling.

F. Each box or package shall be properly marked to show its net weight in addition to its contents.

1.10 WARRANTY

A. All equipment supplied under this section shall be warranted for a period of two years by the pump manufacturer. Warranty shall cover 100% parts and labor for the first year and 50% parts and labor the second year. Warranty period shall commence on the date of Owner acceptance, as outlined in Division 1.

B. The equipment shall be warranted to be free from defects in workmanship, design and materials. If any part of the equipment should fail during the warranty period it shall be replaced in the machine(s) and the unit(s) restored to service at no additional cost to the Owner

C. The manufacturer's warranty period shall run concurrently with the Contractor's warranty period. No exception to this provision shall be allowed.

D. Refer to Section 01740 for additional warranty requirements.

PART 2 PRODUCTS

2.01 MATERIALS AND EQUIPMENT

A. The pumping units required under this Section shall be complete including pumps and motors with proper alignment and balancing of the individual units. All parts shall be so designed and proportioned as to have liberal strength, stability, and stiffness and to be especially adapted for the work to be done. Ample room shall be provided for inspection, repairs, and adjustments.

B. Stainless steel nameplates giving the name of the manufacturer, the rated capacity, head, speed, and all other pertinent data shall be permanently attached to each pump and motor.

2.02 PUMPING SYSTEM - GENERAL

A. The pumps shall be vertical close coupled, solids-handling centrifugal pumps with vertical TEFC motors. The pumps shall be designed to operate in a dry pit environment, while operating at varying speeds on variable frequency drives. The pumps shall be as manufactured by Fairbanks Morse or engineer approved equal.

B. Each pumping unit and its driving equipment shall be designed and constructed to withstand the maximum turbine run-away speed of the unit due to back flow through the pump.

C. The pump manufacturer shall factory test all pumps prior to shipment in accordance with the standards of the Hydraulic Institute. See Paragraph 3.03A3.e below.

D. See the Pump Data Table (Table 11307-1) at the end of this Section for the pump performance requirements.

2.03 PUMP CONSTRUCTION

A. The overall pump design shall combine high efficiency, low required NPSH, large sphere passage and the ability to handle high solids concentrations efficiently. The impeller/casing design shall result in a passage free of surfaces to which solid or fibrous materials can adhere. The design shall permit low liquid velocities and gradual acceleration and change of flow direction of the pumped media.

B. Impellers shall be constructed of ASTM A48, minimum Class 30 gray cast iron. The impeller shall be of a centrifugal enclosed, non-clog type, capable of passing fibrous material and minimum solids diameters as indicated on the Pump Data Table.

C. Each pump shall be provided with hardened stainless steel wear rings. The wear ring system shall consist of a stationary wear ring and a rotating wear ring attached to the impeller. Both the rotating and stationary wear rings shall be of 410-484 series stainless steel with a minimum hardness of 300-350 Brinnel. The rotating wear ring hardness shall be lower than that of the stationary wear ring such that the impeller ring wears in preference to the stationary ring.

D. All external pump and motor parts shall be of close grained cast iron, ASTM A48, minimum Class 30 construction with all parts coming into contact with wastewater protected by corrosion resistant coatings except the wear resistant impellers specified in paragraph 2.03B. All external bolts and nuts shall be of Type 304 stainless steel.

E. The minimum discharge size for the pumps as stated in the Pump Data Table shall be the minimum allowable nominal diameter of the discharge connection provided for attachment of the discharge piping. The pump casing shall have machined ANSI 125 lb flanges.

F. The suction head shall be of the same material as the casing, foundry certified, cast separate from the volute and shall contain the suction wear ring. The suction head shall include a suction nozzle, which shall be provided with a handhole. The inner contours of the handhole cover shall match the contours of the suction head. Handholes located in the suction elbow are not an acceptable substitute for handholes in the suction head.

G. The pump shaft shall be made from high grade heat treated alloy steel, rigid shaft type, of sufficient size to transmit the full driver horsepower with a liberal safety factor, accurately machined over its entire length and free from any harmful or damaging vibrations. A renewable stainless steel shaft sleeve extending from the impeller hub through the stuffing box shall be provided. The shaft sleeve shall be internally ground to approved tolerances and positively secured to the shaft by a minimum of two set screws or a key to prevent relative rotation. Passage of water between the shaft and sleeve shall be prevented by "O" rings or other approved means. Shrink fit shaft sleeves will not be acceptable. In order for the mechanical seal set screw to bite, the shaft sleeve shall be 316 stainless steel.

H. Each pump shall be provided with bearings, both radial and thrust, of the anti-friction ball or tapered-spherical roller type, of ample size to carry all loads imposed under continuous operation without overheating. All bearings shall be accessible while the pump is in

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operation. The bearings shall be grease lubricated and a relief port lip seal shall be provided so that excessive grease pressure will not damage the bearings. Grease lines shall be extended to within reach from the floor from application points which would otherwise be out of reach. One hand-type grease gun shall be furnished. Bearings shall be designed in accordance with the ABMA standards for minimum L-10 life of 100,000 hours, calculated at 75% of BEP flow, without the addition of external cooling.

I. The pump bearing frame shall be equipped with a bearing system designed to accept all thrust loadings and the radial loads imposed by the pump impeller. Each bearing frame shall be designed so that the complete rotating element can be removed from the casing without disconnecting the piping. The bearing frame shall be of one piece ASTM A48 class 30 cast-iron construction, completely enclosing all bearings, and shall be designed to provide a self-centering and self-indexing fit with the wetted end of the pump to insure proper alignment of the bearings and stuffing box. A large opening shall be provided adjacent to the stuffing box to facilitate packing or seal adjustment and replacement. Fabricated bearing housings are not acceptable.

1. The minimum distance between the radial and thrust bearings shall be greater than the cantilever distance between the inboard (radial) bearing and the centerline of the impeller, except for pumps with opposed tapered roller bearing systems, where the shaft section inboard of the radial bearing shall be increased instead.

2. The bearing frame shall contain an external provision for axial adjustment of the rotating element to provide proper clearance between the impeller and suction cover over the life of the pump. Adjustment shall be accomplished with integral external jacking screws. Coded shim packs shall be included between the frame and the frame support to aid in maintaining parallelism of seal faces when adjusted. Pumps without this feature are not acceptable.

3. All bearings shall be accessible while the pump is in operation. The bearings shall be grease lubricated, and relief shall be provided so that excessive grease pressure will not damage the bearings.

4. For protection of bearings during shipment and installation, the bearings shall be properly processed with a high quality rust preventative.

J. The pump manufacturer shall furnish 20-inch x 12-inch Turbo-Free cast iron suction reducing elbows for RAS pumps associated with Secondary Clarifiers No. 1 and No. 2. The pump manufacturer shall furnish 12-inch x 8-inch long radius cast iron suction reducing elbows for RAS pumps associated with Secondary Clarifier No. 3, with ½-inch gauge connections and 125 lb flat face ANSI flanges. Drilling shall match alignment of pump suction bolt. The pump manufacturer shall furnish 6-inch x 4-inch long radius cast iron suction reducing elbow for WAS pump associated with Secondary Clarifier No. 3, with ½-inch gauge connections and 125 lb flat face ANSI flanges. Drilling shall match alignment of pump suction bolt.

K. A separately cast close-grained cast iron back head with large access openings and integral sealing box conforming to ASTM A48 Class 30 shall be provided. The sealing box shall be designed for a mechanical seal.

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a. The mechanical seal must be a stationary design and capable of handling full vacuum to 100 PSI. Each seal shall be hydraulically balanced, have self-aligning faces and two threaded ports for flushing/venting. The initial site installation of the split seal will be made with non-split faces. If the seal is repaired or replaced after initial installation and assembly of the pump, all seal parts, including seal faces will be split. Each pump shall be equipped with a Chesterton 442 split mechanical seal or equal.

b. The seal gland shall be manufactured of 316 stainless steel and shall be of a universal design with bolting tabs to fit varied bolt sizes and bolt circles. The gland shall have a minimum of two tapped flush/by-pass ports that can be rotated 360 degrees to accommodate flush piping. O-rings shall be of Aflas material of the ball, socket type, and use no glue. Seal faces shall be of silicon carbide for both the rotating face and stationary face. The rotary holder shall be of high pressure design and shall be set-screwed to the shaft sleeve to assure zero axial movement.

c. The pump manufacturer shall install an active throat bushing in the bottom of each stuffing box to convert the radial flow created inside the seal area into axial flow to remove any solids away from the seal. The active throat bushing shall be made of 416 stainless steel. A stainless steel braided vent line to suction shall be provided from the seal to the suction elbow.

2.04 MOTORS

A. Motors shall be totally enclosed (TEFC) fan cooled with an in-line "P" base.

B. Motors shall be premium efficiency, inverter grade, pulse-resistant Class F magnet wire, heavy phase and special end turn racing techniques. Motors will have normally closed thermostats. Motors shall be manufactured by U.S. Motors, division of Emerson Electric, or engineer approved equal.Motors shall have refined balance.

2.05 VARIABLE FREQUENCY DRIVES

A. Variable Frequency Drives shall be provided for each of the pumps and shall be furnished by the contractor. The contractor shall coordinate between pump manufacturer and VFD manufacturer to insure a complete and properly functioning system.

B. The variable frequency drives shall be PWM type suitable for use with the submersible motors, as specified above.

C. The variable frequency drives shall be as specified in Section 16482.

PART 3 EXECUTION

3.01 INSTALLATION

A. Installation shall be in strict accordance with the manufacturer's instructions and recommendations in the locations shown on the Drawings. The Contractor shall furnish all required oil and grease for initial operation, if required, in accordance with the manufacturer's

recommendations. Anchor bolts shall be set in accordance with the manufacturer's recommendations.

B. Upon completion of the pump station, the manufacturer shall inspect the installation and submit a certificate stating that the installation of the equipment is satisfactory, that the equipment is ready for operation, and that the operating personnel have been suitably instructed in the operation, lubrication and care of each unit.

3.02 SHOP PAINTING

A. Before exposure to weather and prior to shop painting, all surfaces shall be thoroughly cleaned, dry and free from all mill-scale, rust, grease, dirt and other foreign matter.

B. All pumps and motors shall be shop coated with a suitable epoxy coating system.

C. All nameplates shall be properly protected during painting.

D. Gears, bearing surfaces, and other similar surfaces obviously not to be painted shall be given a heavy shop coat of grease or other suitable rust-resistant coating. This coating shall be of the type required to prevent corrosion during the period of storage and shall be satisfactory to protect the pumps up to the time of the final acceptance test.

3.03 INSPECTION AND TESTING

A. General

1. The Engineer shall have the right to inspect, test or witness tests of all materials or equipment to be furnished under this Section, prior to their shipment from the point of assembly.

2. The Engineer shall be notified in writing prior to initial shipment or testing, in ample time so that arrangements can be made for inspection by the Engineer.

3. The pump manufacturer shall perform the following test on each pump prior to shipment from factory:

a. Measure motor for insulation breaks or moisture.

b. Each pump provided under this section shall receive a performance test in accordance with, Hydraulic Institute Standards. Test shall be performed on the actual units pumps and motors) to be provided at the point of manufacture. Testing shall include at least Flow, Total Head, Input HP, and Wire to Water Efficiency and shall include a minimum of seven points on the full speed curve from shut-off to the secondary operating condition. All electronic transducers, meters, gauges, and other test instruments shall be calibrated within thirty working days prior to the scheduled test and certified calibration data provided. If any pump tested fails to meet the specified requirements and all reasonable attempts to correct the non-compliance are unsuccessful, it will be rejected. No shipment shall be permitted until the Engineer has approved the test results. All test results shall be signed and sealed by the

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Manufacturer's registered professional engineer, who shall have actually witnessed the testing of all units, and shall be submitted for review and approval prior to shipment.

c. A written certification test report regarding the above tests shall be supplied with each pump at the time of shipment..

4. As specified in Paragraph 3.01B, the manufacturer shall furnish the services of a factory representative who shall have complete knowledge of proper operation and maintenance to inspect the final installation and supervise the test run of the equipment. The manufacturer shall include in his price, a minimum of 8 hours of a representative's time.

5. Field tests shall not be conducted until such time that the entire installation for each pump is complete and ready for testing.

6. In the event that the equipment does not meet the Final Acceptance Test, the Contractor shall, at his own expense, make such changes and adjustments in the equipment which he deems necessary and shall conduct further tests until full satisfaction is indicated by the Engineer and written certification is received thereof.

B. Pumps

1. After all pumps have been completely installed, and working under the direction of the Contractor, the Pump Manufacturer shall conduct in the presence of the Engineer such tests as are necessary to indicate that pumps conform to this Section. Field tests shall include all pumps included under this Section. The Contractor shall supply all electric power, water or wastewater, labor, equipment and incidentals required to complete the field tests.

2. The Final Acceptance Test shall demonstrate that all items of this Section have been met by the equipment as installed and shall include, but not be limited to, the following tests:

   a. That all units have been properly installed and are in correct alignment.

   b. That the units operate without overheating or overloading any parts and without objectionable vibration.

   c. That there are no mechanical defects in any of the parts.

   d. That the pumps can deliver the specified pressure and flow.

   e. That the pump sensors and controls perform satisfactorily as to sequence control, correct start and stop elevations, and proper level alarm functions.

   f. Pump test in the presence of the Engineer to confirm the pump flow rates.

3. If the pump performance does not meet the specified requirements, corrective measures shall be taken or pumps shall be removed and replaced with pumps which satisfy the conditions specified. A 72-hour operating period of the pumps will be required before acceptance.

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4. Each pump will undergo field vibration analysis to confirm that it meets the requirements of 1.06 G. of this Section. Vibration analysis is to be conducted at the minimum and maximum speeds and at 5% intervals (3 hz intervals) throughout the operating range between the minimum and maximum speeds.

C. Motors

1. The Contractor shall check all motors for correct clearance and alignment and for correct lubrication in accordance with manufacturer's instructions. The Contractor shall check direction of rotation of all motors and reverse connections if necessary.

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TABLE 11307-1

PUMP UNIT DESIGN REQUIREMENTS

| Criteria Item | Design Conditions RAS Pumps | WAS Pumps |
|---|---|---|
| Maximum Motor to be Supplied (hp) | 10 | 15 |
| Maximum Pump Design Speed (rpm) | 705 | 1,800 |
| Number of Units to be Provided | 5 | 3 |
| Minimum Discharge Size (inches) | 8 | 4 |
| Minimum Suction Size (inches) | 8 | 4 |
| Minimum Pump Shut-Off Head at Design Speed (feet) | 30 | 90 |
| Primary Capacity (gpm) | 1690 | 450 |
| Minimum TDH at Primary Capacity (feet) | 15 | 58 |
| Minimum Wire to Water Efficiency at Primary Capacity (%) | 78 | 65 |
| Minimum Size Solids (inches) Passing | 4.0 | 3.0 |
| Maximum NPSH Required @ Runout | 10 | 25 |
| Maximum Weight of rotating assembly (motor and impeller) (lbs) | 2,200 | 800 |
| Pump Models Used for Design (Fairbanks Morse) | 8"5434 | 4" 5412 |

END OF SECTION

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SECTION 11318

# MIXED LIQUOR INTERNAL RECYCLE PUMPS

## PART 1 GENERAL

### 1.01 SCOPE OF WORK

A. Furnish all labor, materials, equipment and incidentals required and completely factory test, install, put in operation and field test the submersible electrical motor driven horizontal propeller pumps to be used for recirculating nitrified aeration tank mixed liquor back to the anoxic tanks as shown on the Drawings and as specified herein.

B. All units shall be furnished and installed with all necessary accessory equipment required for a complete, operational pumping system including factory testing and field testing of all pumps and instructing the Owner's personnel in the care, operation, and maintenance of all equipment. Accessory equipment shall include pipe flange mounting connections, guide rails, lifting chains guide bar brackets, platform-mounted crane and thermal and moisture sensor control and monitoring unit.

C. The pump manufacturer shall coordinate the pump drive requirements, including the sizing of motors and variable frequency drive controllers, with the motor and variable frequency drive controller manufacturers.

D. Submersible electric motors shall be furnished as part of the work of this Section.

E. Variable frequency drive controllers with bypass starters shall be furnished for each pump as part of the work of this Section and shall be as specified in herein and in Specification 16482.

F. Control panel for thermal and leakage sensor relays shall be furnished as part of the work of this Section and as specified herein and in Specification 16000.

### 1.02 RELATED WORK

A. Maintenance of Plant Operations is included in Division 1.

B. Electric Motors as specified herein shall conform to the requirements of Division 16.

C. Control Panels are included in Division 16.

D. Miscellaneous metal is included in Division 05.

E. Concrete is included in Division 03.

F. Painting except as specified herein is included in Division 09.

G. Piping, valves, and similar mechanical work is included in Division 15.

H. Process instrumentation is included in Division 13.

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I. Variable Frequency Drives is included in Division 16.

1.03 SUBMITTALS

A. Submit, in accordance with Section 01300, copies of all materials required to establish compliance with this Section. Submittals shall include the following:

1. Manufacturer's rating curves showing design and secondary points, pump characteristics of discharge, head, capacity, brake horsepower, efficiency, required net positive suction head, and required minimum and maximum submergence. Variable speed curves shall also be provided with five speeds plotted from maximum to minimum recommended RPM. Minimum RPM shall be as recommended by the manufacturer. Curves shall be submitted on 8-1/2 x 11-in sheets, at as large a scale as is practical. This information shall be prepared specifically for the pumps proposed. Catalog sheets showing a family of curves will not be acceptable.

2. Structural calculations for pump support systems including all forces, thrusts, torques, and bending moments that will be exerted by the units under all conditions of operation, as well as the size of structural support members required.

3. Literature and drawings describing the equipment in sufficient detail, including parts list and materials of construction, to indicate full conformance with the detail specifications. Sales literature alone is not acceptable. Information provided herein shall be arranged, identified, and bound in sequence. Suitable index shall be provided.

4. Certified dimensional drawing of each item of equipment and auxiliary apparatus to be furnished showing all important details of construction and anchor bolt sizes and locations. Include all mounting details for pump and crane.

5. The total weight of the equipment including the weight of the single largest item.

6. A complete and total bill of materials for all equipment.

7. A list of manufacturer's recommended spare parts to be supplied in addition to those specified in Paragraph 1.09 with the manufacturer's current price for each item. Include gaskets, packing, etc on the list. List bearings by the bearing manufacturer's numbers only.

8. Complete data on motors and variable frequency drives as specified herein.

9. A statement indicating bearing life.

10. Certification from pump manufacturer that the submittal has been coordinated with the manufacturers of the motor and variable frequency drive controller.

11. Complete description of surface preparation, shop prime and finish painting if applicable.

12. Schematic electrical wiring diagram and other data as required for completion of each pump installation, including variable speed drivers, including thermal and leakage sensor controls and control panel.

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13. Manuals as noted below.

14. Information on shipping and Certificate of Installation per PART 3.

15. Certified factory and field test results per PART 3.

B. Submit a Draft and Final Operations and Maintenance Manual to the Owner in accordance with Section 01730. The instructions shall be prepared specifically for this installation and shall include all required catalog cuts, drawings, equipment lists, and descriptions necessary to instruct operating and maintenance personnel unfamiliar with such equipment. Installation drawings, wiring diagrams, and maintenance requirements shall all be included. Furnish for review by the Owner a draft version of the O&M Manual. Respond to Owner comments and furnish three final copies of final O&M Manual to the Owner in 3-ring binders.

C. In the event that it is impossible to conform with certain details of these Specifications due to different manufacturing techniques, describe completely all nonconforming aspects.

1.04 REFERENCE STANDARDS

A. American Gear Manufacturers Association (AGMA)

B. National Electrical Manufacturers Association (NEMA)

C. American Iron and Steel Institute (AISI)

D. Hydraulic Institute Standards

E. Where reference is made to one of the standards, the revision in affect at the time of the bid opening shall apply.

1.05 QUALITY ASSURANCE

A. The equipment covered by this Section is intended to be standard pumping equipment of proven ability as manufactured by reputable concerns having extensive experience and regularly engaged in the production of such equipment. All units specified herein shall be furnished by a single manufacturer.

B. The pumps and controls shall be designed and built for 24-hour continuous service at any and all points within the required range of operation, without overheating, without cavitation, and without excessive vibration or strain. All parts shall be so designed and proportioned as to have liberal strength, stability and stiffness and to be especially constructed to the specified requirements.

C. Pump and motor shall be by the same manufacturer. All units shall be identical. The equipment furnished shall be designed, constructed, and installed in accordance with the best practice and methods, and shall operate satisfactorily when installed as shown on the Drawings.

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D. The pump manufacturer shall supply and be responsible for compatibility of the complete pumps, with motors mounted thereon, along with variable frequency drives. Units shall be shipped ready for installation requiring only proper setting on bases, piping and electrical connections to function.

E. Should equipment, which differs from that specified herein or shown on the Drawings, be offered and determined to be equal to that specified, such equipment shall be acceptable only on the basis that any revisions in the design and/or construction of the structure, piping, appurtenant equipment, electrical work, etc required to accommodate such a substitution shall be made at no additional cost to the Owner and be as approved by the Engineer.

1.06 DESCRIPTION OF SYSTEMS

A. All pumps described in this Section shall be installed with specified accessories and lifting devices, as shown on the Drawings, in the two existing and one new aeration basins. The units will recycle mixed liquor from the Aeration Basins to the Anoxic Selectors, through the piping arrangement shown on the Drawings. The piping is to extend to the face of the overhanging walkway slab, as shown on the drawings. Pumps shall operate within the system as discussed in Section 1.06.

B. All pumps, motors, and variable frequency drive units shall be provided as a matched package by the pump manufacturer. Equipment characteristics specified shall be those of actual installed system. Specified efficiencies are those of pump and motor. Specified delivery flow at head conditions shall be those obtainable with the variable frequency drive, pump, and motor supplied and installed in the field.

C. All pumps supplied under this Section shall be supplied by one manufacturer and shall be one model type. One variable frequency drive shall be supplied for each pump.

D. Pump Operation

1. In automatic operation mode, pump operation and speed are controlled by the plant flow signal.

2. In the manual mode, the plant operator controls pump operation and adjusts the speed of the pumps locally at the VFD in the electrical room in the new Electrical Building.

3. Pumps will normally run continuously, except for periodic shut down for maintenance.

4. Pump Starting/Stopping Sequence - General: The pumps will normally start and stop against a full pipe and in a full aeration tank.

5. Pump "Bypass" Operation - for Variable Speed Pumps: Pumps shall be operable without the variable frequency drive using the electrical bypass and VFD isolation furnished by the VFD drive manufacturer. In this mode, the pumps, when called for to be energized, are started at full voltage and run at full speed. This VFD isolation and bypass feature shall be furnished with the VFD in the VFD enclosure.

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6. Thermal and leakage detection sensors shall shut the motor down if temperature or moisture content exceeds the manufacture's recommended threshold. See Paragraph 2.01D herein for thermal and leak detection control panel.

7. Pumping Staging and Speed Control - General

   a. Pumps shall pump at a rate proportional to plant flow.

   b. Exact determination of allowable and maximum/minimum speeds will be in accordance with the unit's manufacturer recommendations, and specified operating conditions.

   c. The above information will be programmed into the plant control system and will be adjustable. Programming is not a part of the work of this Section.

   d. See Division 13 for additional control logic and speed control (pacing).

E. Pump Operating Conditions

1. Definition of Pumping Terms - All pumping terms shall be as defined in the Hydraulic Institute Standards, latest edition.

2. All pumps shall have a constantly rising head capacity curve from minimum recommended operating point to shutoff head. Design capacity and head conditions must be met at the maximum speed of the driver.

3. The pumps shall be certified as being able to operate, in a stable manner, continuously for an extended period of time at any point on their curve, between the limits specified and as otherwise noted, and in the environmental conditions noted without cavitation, overheating, or excessive vibration. The required motor nameplate horsepower and service factor shall not be exceeded by the pumps' brake horsepower requirements along any point on the pump curve utilized, at any required rpm including the pump shut-off head. Similarly, the minimum submergence required by the pump at any point along the pump curve utilized, at any required rpm, shall not exceed the minimum submergence available.

F. Pumping units design requirements:

| | | | |
|---|---|---|---|
| 1. | Location: | | Aeration Basins |
| 2. | Type of units: | | Horizontal submersible propeller |
| 3. | Drives | | |
| | a. | Type: | Special electrical submersible motors |
| | b. | Voltage/phase/Hz: | 460/3/60 |
| | c. | Service factor: | 1.1 |
| | d. | Insulation/cooling | See PART 2 |
| | | Enclosure: | See PART 2 (special submersible) |
| | e. | Mounting: | Submerged, direct coupled, horizontal Per Mfr. (Pipe Flange Mount) |

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| | | | |
|---|---|---|---|
| | f.<br>g.<br>h. | Motor horsepower (maximum):<br>Max. Rotation speed (rpm):<br>Min. Rotation speed (rpm): | 15<br>1680<br>As recommended by pump manufacturer. |
| 4. | Maximum starts per hour: (Using Variable Frequency Drive Units) | | 10 |
| 5. | Controls: | | As noted in Paragraph 1.06D |
| 6. | Fluid Pumped : | | Biological solids with a concentration of up to 5500 mg/L. |
| 7. | Number of Units: | | 1 per aeration basin; Total of 3 units |
| 8. | Pump characteristics: | | |
| | a.<br>b.<br>c.<br>d.<br>e. | Capacity and Head:<br>Minimum efficiency at design point:<br>Pump speed at design capacity (max):<br>Minimum Submergence available:<br>Approximate Static Head: | 9,900 gpm at 2.5 feet<br>60 percent<br>580 rpm<br>120-in<br>0.1 ft to 0.2 ft |
| 9. | Pump connection | | |
| | a.<br>b. | Type:<br>Outlet size (minimum diameter): | Pipe Flanged Mount<br>24-in, to be mated to 24-in IR piping |
| 10. | Bearing (B-10) Life - minimum hours: | | 100,000 |

G. Balance/Vibration and Support Design

1. The pump manufacturer shall be fully responsible for the design, arrangement, and operation of all connected rotating components and checking the guide rails, wall mount flange and supporting structure for the assembled pumping units to ensure that neither harmful or damaging vibrations shall occur at any speed within the specified operating range.

1.07 DELIVERY, STORAGE AND HANDLING

A. All parts shall be properly protected so that no damage or deterioration will occur during a prolonged delay from the time of shipment until installation is completed and the units and equipment are ready for operation.

B. All equipment and parts must be properly protected against any damage during a prolonged period at the site.

C. Factory assembled parts and components shall not be dismantled for shipment unless permission is received in writing from the Engineer.

D. Finished iron or steel surfaces not painted shall be properly protected to prevent rust and corrosion as specified in Sections 09901 and 09902.

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E. No shipment shall be made until approved by the Engineer in writing.

1.08 MAINTENANCE

A. Operating Instructions

1. Complete sets of startup, operating and maintenance instructions for each piece of equipment included under these specifications shall be furnished in accordance with Section 01730. The manuals shall be prepared specifically for this installation and should include all cuts, drawings, equipment lists, descriptions, etc that are required to instruct operating and maintenance personnel unfamiliar with such equipment.

2. A manufacturer's factory engineer who has complete knowledge of proper startup, installation, and operation and maintenance (O&M) shall be provided for a total of 3 days to provide assistance during installation, startup, and testing and one additional day to instruct representatives of the Owner and the Engineer on proper operation and maintenance.

3. If equipment is improperly manufactured, installed, or tested, or otherwise requires additional attention by the manufacturer's representative, additional services shall be provided at no additional cost to the Owner.

B. Tools and Spare Parts

1. Provide one set of all special tools as required for the proper servicing of all equipment supplied under this Section, which shall be packed in a suitable steel tool chest with a lock.

2. One pumping unit of the same type, model, and size, including pump and motor, shall be furnished as a backup pump and not installed. The unit shall be complete and ready for insertion into one of the aeration basins in the event of failure or maintenance of one of the two installed pumps. Provide all packaging, lubricants, instructions, etc required for proper storage of the unit while not in service.

3. There shall also be supplied for each of the 2 installed pumps, the manufacturer's standard set of spare parts including at least the following:

a. Complete set of shaft seals (inner and outer).

b. Complete set of gaskets and o-rings.

c. One complete set of bearings.

d. One spare power cable grommet.

e. Oil of the type recommended by the manufacturer. Quantity shall be enough for at least two oil changes per pump. This shall be in excess of any oil required for start up.

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PART 2 PRODUCTS

2.01 GENERAL

A. This Section calls attention to certain features, but does not purport to cover all details of construction of the units.

B. For all pumps, location and size of pipe flange connection shall be as specified herein and as shown on the Drawings.

C. The pumping units required under this Section shall be complete including pumps and motors, all specified accessories, and all appurtenances necessary to comprise a complete functioning system. Variable frequency drives shall be matched to the pumps and supplied by the pump manufacturer.

D. A control panel for thermal and leakage detection sensors shall be furnished for each installed pump and shall be factory wired, such that field wiring connections shall require connection of power and control/sensory wiring to the control panel and to the pumps. Field wiring connections shall be to numbered terminal strips. The entire control system shall be factory tested before shipment. The panels shall be rail mounted in the proximity of the pumps as shown on the Drawings.

1. Each pump shall be provided with a NEMA 4X stainless steel control panel, suitable for outdoor installation, located locally. The control panel shall contain all necessary relays, devices, equipment and logic for a fully functional system.

2. The control panel shall include, at a minimum, the following:

a. Thermal and leak detection units.

b. The panel shall utilize 120 V, single phase power from VFD control power transformer and transform it to other voltages necessary for control.

c. Indicating lights and relays for each of the following alarms and conditions:

1) Water inside mixer gearbox at motor (shut down) - Leakage

2) Winding high temperature (shut down) - Thermal

3) Motor running

d. Output dry contacts for leakage and thermal signals to the SCADA system.

e. Quick (plug) connection for the pump flexible cable.

f. Reset button and indicating lights shall be mounted on the panel door.

E. Each VFD control panel shall not exceed 36-in in width. The VFD for each pump shall include a bypass and isolation feature to allow the pump to run at full speed. VFDs shall be as specified herein.

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F. Provide an emergency STOP pushbutton in a NEMA 4X stainless steel enclosure mounted next to the local control panel. The push-button shall be a double pole with two sets of normally open and two sets of normally closed maintained contacts rated for 10 amperes at 120 volts AC and shall have a red mushroom head operator.

G. All parts shall be so designed and proportioned as to have liberal strength, stability, and stiffness and to be specially constructed for the work to be done.

H. All necessary nuts, bolts, plates, brackets, sleeves, and washers shall be furnished by the pump manufacturer, coordinated and installed by the Contractor. Anchor bolts shall be Type 316 stainless steel.

I. Stainless steel (ASTM A276, Type 304) nameplates giving the name of the manufacturer, the rated capacity, head, speed and all other pertinent data shall be attached to each pump and motor.

J. Balance/Vibration. All rotating parts shall be accurately machined and shall be in as nearly perfect rotational balance as practicable.

K. All electrical materials and equipment shall be UL listed or FM approved and NEMA rated and shall otherwise be equal to that supplied under Division 26, where applicable.

L. Pump units shall be Flygt, ABS Pumps, Inc. or equal, and suitable for pipe flange mounting as shown on the Drawings.

2.02 MATERIALS OF CONSTRUCTION

A. Unless otherwise noted, the pumps shall be constructed of the following materials:

| | |
|---|---|
| 1. Motor Cable: | Chloroprene rubber jacketed |
| 2. Cable Entry and Pump Top: | Type 316 stainless steel |
| 3. Cable Entry Grommets: | Fluorinated rubber |
| 4. Inner Stator Base: | Cast iron (AISI 835) |
| 5. Outer Stator Jacket: | Type 316 stainless steel |
| 6. Shaft: | Stainless steel (Type 420 stainless steel) |
| 7. Lubricant Housing Cover: | Vinylester (fiberglass reinforced) |
| 8. Propeller: | Type 316 stainless steel |
| 9. Propeller Cover: | Vinylester (fiberglass reinforced) |
| 10. Inlet Cone: | Type 316 stainless steel |
| 11. O-Ring: | Buna-N |

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12. Outer Mechanical Seal: Tungsten carbide

13. Inner Mechanical Seal: Tungsten carbide

14. Pipe Mount Discharge Connection: Type 316 Stainless Steel with circular flange

15. Upper Guide Bar Bracket: Type 316 Stainless Steel

2.03 PUMP DESIGN

A. The pumps shall be capable of pumping biological solids with a concentration of up to 5500 mg/L.

B. The pumps shall be able to be raised and lowered and shall be easily removed for inspection or service without the need for personnel to enter the aeration tanks. Provide all required accessories for removal.

C. The pump, with its appurtenances and cable, shall be capable of continuous submergence under sewage without loss of watertight integrity to a depth of 17 feet.

2.04 PUMP CONSTRUCTION

A. Each pump shall be of the integral design, close coupled, horizontal, submersible type. All components of the unit, including motor shall be capable of continuous underwater operation.

B. Major pump components shall be of Type 316 stainless steel construction. The lubricant housing cover plate shall be of corrosion resistant composite. All exposed nuts and bolts shall be of Type 316 stainless steel.

C. All metal surfaces coming into contact with the pumped media, other than stainless steel, shall be protected by a factory applied spray coating of acrylic dispersion zinc phosphate primer with a polyester resin paint finish on the exterior of the pump.

2.05 MOTOR

A. The pump motor shall be squirrel cage, induction, shell type design, housed in an air filled, watertight chamber. Pump motors shall be inverter-duty rated for use with variable frequency drives. Pump motors shall be 460 Volt, 3 Phase, 60 Hz and shall be NEMA Design B.

B. The stator winding shall be insulated with moisture resistant Class F insulation that will resist a temperature of 155 degrees C (311 degrees F). The stator shall be dipped and baked three times in Class F varnish.

C. The motor shall be designed for continuous duty, capable of sustaining a maximum of at least 10 evenly spaced starts per hour. The pump motors shall be capable of running without damage for extended periods of time.

D. Motors shall be provided with pilot thermal sensors embedded in the stator windings. Motors shall be provided with leak detection in the stator chamber. These sensors shall be used in conjunction with, and supplemental to, external motor overload protection, and wired to a

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sensor control and status monitoring panel furnished with the motor. Unit shall be rail mounted in the vicinity of each pump.

E. Furnish 25-ft of motor cable with sensor control wire to connect to a junction box provided as part of the work of Division 26.

2.06 ELASTOMERS

A. All mating surfaces where watertight sealing is required shall be machined and fitted with double Nitrile rubber or Viton O-rings. Fitting shall be such that sealing is accomplished by metal-to-metal contact between machined surfaces. This will result in controlled compression of the O-rings without requiring a specific torque limit.

B. No secondary sealing compounds, rectangular gaskets, elliptical O-rings, grease, or other devices shall be used.

2.07 PROPELLER

A. The propeller shall be of Type 316 stainless steel, dynamically balanced, nonclogging, backward curved design.

B. The propeller shall be capable of handling solids, fibrous materials and other matter found in normal sewage applications. The propeller shall be approximately 23-in in diameter and have three blades.

2.08 CABLE ENTRY

A. The cable entry housing shall be an integral part of the back plate. The cable entry shall have a double set of elastomer grommets in order to ensure a redundant system in the event of a cable entry seal failure. Single sealing systems will not be acceptable.

B. The cable entry shall be comprised of two cylindrical elastomer grommets, each flanked by washers and a ferrule designed with close tolerance fit against the cable outside diameter and the entry inside diameter. This will provide a leak-proof, torque-free seal at the cable entrance. The assembly shall bear against a shoulder in the stator casing opening and be compressed by a gland nut threaded into it. Interaction between the gland nut and the ferrule should move the grommet along the cable axially instead of with a rotary motion.

C. The junction chamber and motor compartment shall be separated by a terminal board that shall protect the motor interior from foreign material gaining access into the pump top. Connection between the threaded compressed type binding posts permanently affixed to the terminal board and thus perfectly leak-proof.

D. Epoxies, silicones, or other secondary sealing systems will not be acceptable.

2.09 BEARINGS

A. All bearings shall have a minimum B-10 rated life as specified in PART 1.

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B. The outboard propeller bearing shall be an angular contact bearing. The motor shaft end shall be supported by two bearings. A roller and an angular contact bearing shall take up the axial and radial loads while an angular contact bearing shall take up the axial loads.

C. The bearings shall be preloaded by a bearing loading nut located on the motor end of the shaft in order to reduce shaft deflection and increase bearing life and seal life. Pumps without preloaded bearings will not be considered acceptable or equal.

D. Bearings shall be isolated from possible seal leakage by means of a drain port behind the mechanical seals.

2.10 SHROUD ASSEMBLY

A. The pump assembly shall incorporate a full 360 degrees bell shaped inlet shroud around the propeller. A maximum clearance of 1/2-in shall be maintained between the propeller tip and the shroud in order to maintain hydraulic efficiency and power consumption.

2.11 LUBRICANT HOUSING

A. The lubricant housing shall contain two compartments consisting of an inner and an outer section with four ports to connect and facilitate lubricant flow.

B. In the event that the media bypasses the outer seal, this design will allow the outer compartment to collect the heavier (denser) fluids by means of the simple process of gravity.

2.12 MECHANICAL SEALS

A. Each pump shall be provided with two sets of lapped and face type mechanical seals running in lubricant reservoirs for cooling and lubrication. The mechanical seals shall contain both stationary and positively driven face rings.

B. In order to avoid seal failure from sticking, clogging, and misalignment from elements contained in the mixed media, only the seal faces of the outer seal assembly and its retaining clips shall be exposed to the mixed media. All other components shall be contained in the lubricant housing. All seal faces must be solid material capable of being relapped.

C. The seals shall require neither maintenance nor adjustment, but shall be easy to check and replace. Shaft seals without positively driven rotating members shall not be considered acceptable or equal.

D. Seal lubricant shall be FDA approved, nontoxic.

2.13 REMOVAL AND CONNECTING MECHANISM

A. Each pump shall be provided with a lifting handle, suitable for use with a lifting cable.

B. Mounting/Connection

1. Each pump's mounting railings shall be permanently installed in the tank along with the discharge piping flange mount discharge connection as shown on the Drawings. The

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flange mount discharge connection shall have a circular flange for bolting to a 24-in pipe furnished under Division 15, using reducers if necessary. Each pump shall be automatically connected and sealed to its discharge connection pipe when lowered into place and shall be easily removable. Each pump shall be mounted on a sliding guide bracket which is used to guide the pump into place and align it with the discharge connection. The connection shall be the manufacturer's design, as acceptable to the Engineer. Contractor shall provide supports beneath 24-in pipe as required.

2. Sealing of a pumping unit to its discharge connection shall be accomplished by a simple linear downward motion of the pump with the entire weight of the pumping unit guided to the wedging tightly against the discharge connection; no portion of the pump shall bear directly on the floor of the aeration tank and no rotary motion of the pump shall be required for sealing. Sealing at the discharge connection shall be a metal contact of the pump discharge and mating discharge connection.

3. Each pump shall ride on single or dual guide bars when raised and lowered in the tank. Guide bars shall be of standard weight 3-in Type 316 stainless steel pipe. Proper size Type 316 stainless steel rail brackets and hardware shall be provided as recommended by the pump manufacturer. Pump manufacturer shall confirm in writing that no intermediate supports for the guide bars are required, or shall provide all necessary intermediate supports in Type 316 stainless steel.

C. Manual Crane Assembly

1. One platform mounted manual crane assembly shall be provided by the Contractor for each of the 3 installed pumps. The crane shall have sufficient load carrying capacity to raise and lower each pump for installation and service. It shall consist of a lifting davit, winch and lifting cable. The lifting davit assembly shall be constructed of Type 316 stainless steel. It shall contain a lifting cable pulley assembly that is field adjustable to any location on the davit arm. The davit arm shall also be capable of vertical angle adjustments up to 45 degrees from horizontal without loss of load carrying capacity. The crane assembly shall also be easily field installed to the stainless steel slide pump mount assembly without the need for special tools. Total lifting assembly shall weigh no more than 70-lbs.

2. A turning arm handle shall be provided to effectively rotate the mast under lifting loads. The turning arm handle shall be located on the davit arm. The boom shall be designed to rotate 360 degrees and to remove the pump from the tank in a single lifting and rotation motion.

3. Each winch assembly shall be of marine grade construction, supplied with a 40-ft length of 1/4-in Type 316 stainless steel lifting cable.

## 2.14 APPURTENANCES

A. Pump power cable shall be suitable for submersible pump applications. Cable sizing shall conform to NEC requirements for pump motors. Cable entry to each pump shall be designed for submersible pump applications, acceptable to the Engineer.

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B. Pump accessories and appurtenances shall also include, but not be limited to:

1. Power and control/sensory cable holder

2. Hoist, socket and lifting cable

3. Guide rails

4. Upper guide bar brackets and mounting brackets, as required.

C. Provide upper guide bar brackets and mounting brackets on walls to support the pump guide bars as shown on the Drawings.

2.15 FACTORY INSPECTION, TESTS AND CORRECTION OF DEFICIENCIES

A. The Engineer and/or other representative of the Owner shall have the right to inspect and test all materials or equipment to be furnished under this Section, prior to their shipment from the point of manufacture. Contractor shall provide 14 calendar days notice to the Engineer.

B. All factory test data shall be submitted in a bound certified report for review by the Engineer prior to shipping. Test results certifying that each unit is free from electrical or mechanical defects and meets all design specifications shall also be submitted to the Engineer in the test report. See PART 1 for additional required submittal data.

C. All units, complete pump and motor, starter, and variable frequency drive shall be factory assembled, connected, and factory tested as a unit. Certified pump performance curves resulting from these tests shall be included in the factory test report, including head, capacity, KW input, overall efficiency, speed and RPM. Variable frequency drive efficiency and motor efficiency shall be provided for each pump.

D. In addition to the testing noted above, the pump manufacturer shall perform, in order listed, the following inspections and tests on each assembled pump and motor unit before shipment from factory:

1. Impeller assembly details, motor-rating, and electrical connections, etc shall be checked for compliance to these Specifications.

2. A motor and cable insulation test for moisture content or insulation defects shall be made, including vacuum testing to establish sealing integrity.

3. Prior to submergence, the pump shall be run dry to establish correct rotation, followed by a 30-minute submerged test run.

4. After operation is tested the insulation test is to be performed again. (Reseal cable as required).

E. Units shall not be shipped until approval of the factory tests by the Engineer.

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F. Correction of Deficiencies (Applies to both factory and field tests)

1. If, prior to the time of acceptance by the Owner, the pumping units specified in this Section fail to operate as specified herein, the Contractor shall, through the manufacturer and at Contractor's own expense, modify, replace, or rebuild the units until the guaranteed efficiency and capacity are obtained.

2.17 LUBRICANT

A. All units shall be factory filled with lubricant. Grease plugs will not be permitted (to prevent pump bearings from being overgreased). There shall be supplied sufficient lubricant for each pump unit and the first scheduled maintenance.

PART 3 EXECUTION

3.01 INSTALLATION

A. All pumps shall be installed in accordance with the instructions of the manufacturer and as shown on the Drawings. The installation of pumps and motors shall be approved by a factory engineer certified by the manufacturer supplying the equipment.

B. Mechanical and functional tests for each pump shall not be conducted until such time that the entire installation for that pump is complete and ready for testing, and a certificate from the pump manufacturer has been submitted to the Engineer stating that the installation of their equipment is satisfactory and that the equipment is ready for operation.

3.02 FIELD TESTS AND CORRECTION OF DEFICIENCIES

A. In the presence of the Engineer, Owner and pump manufacturer's engineer, the Contractor shall perform such tests as necessary to indicate that the pumps perform mechanically and functionally as specified.

B. The Contractor shall supply all equipment, labor, and materials for field testing. Special coordination will be required with other operating systems.

C. A 24-hour operating period of the pumps will be required before initial acceptance. If pump performance does not meet the requirements specified herein, corrective measures shall be taken or the pumps shall be removed and replaced with pumps that satisfy the conditions specified, at the Contractor's expense. Retesting will then be required. See also Paragraph 2.16.

D. Certified field test reports for the final units accepted by the Owner shall be included with the O&M manuals, after the test results are approved by the Engineer.

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SECTION 11352

SECONDARY CLARIFIER

PART 1 GENERAL

1.01 SCOPE OF WORK

A. Furnish all labor, materials, equipment and incidentals required and install complete and ready for operation, secondary sludge collection and scum removal and appurtenant equipment in Secondary Clarifier No. 1, 2 and 3 as shown on the Drawings and as specified herein. The scope of work shall include, but is not limited to, the procurement and installation of a new center column, an EDI (energy dissipating inlet), a feedwell, spiral scraper blades – inward raking and, if required, oblique scraper blades - outward raking, a sludge withdrawal ring, a drive mechanism, tangential scum skimmers, a platform, access bridge, and access bridge hand railings.

B. Electric motors and power factor correction capacitors (if required) shall be furnished as part of the work of this Section and shall be in accordance with Section 01171.

1.02 RELATED WORK

A. Yard piping is included in Division 2.

B. Concrete work, including grout for clarifier bottoms and sludge rings, is included in Division 3.

C. Field painting, coatings and preparation are included in Division 9.

D. Process Instrumentation is included in Division 13.

E. Mechanical piping, valves, pipe hangers and supports are included in Division 15.

F. Electrical work, except as otherwise specified herein, is included in Division 16.

1.03 SUBMITTALS

A. Submit to the Engineer, in accordance with Section 01300, copies of all materials required to establish compliance with this Section. Submittals shall include at least the following:

1. Certified shop and erection drawings showing all important details of construction, dimensions weld requirements and anchor bolt locations.

2. Descriptive literature, bulletins and/or catalogs of the equipment.

3. The total weight of the equipment including the weight of the single largest item or component.

4. A complete bill of materials for all equipment.

5. A list of the manufacturer's recommended spare parts.

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6. The recommended summer and winter grades of oil or greases along with alternative references to equal products of other manufacturers.

7. Documentation of the AGMA rating of the drive assembly.

8. Complete data on motors and power factor correction capacitors (if required) as specified in Section 01171.

9. Complete description, control diagrams and schematics of torque overload device.

10. Documentation of the design torque rating of the collector mechanism.

11. Description of surface preparation and shop prime paint.

12. A list of at least 10 operating installations of clarifiers.

B. Provide a Statement of Conformance letter stating conformance to the Drawings and Specifications with all exceptions noted. Statement of conformance must be signed by an individual authorized to make such statements. Omission of the Statement of Conformance letter or failure to note all exceptions to the Drawings and Specifications is justification for submittal rejection.

C. Submit certified copies of field test report as specified in PART 3.

1.04 REFERENCE STANDARDS

A. Hydraulic Institute (HI)

B. American Society for Testing and Materials (ASTM)

1. ASTM A36 - Standard Specification for Carbon Structural Steel

2. ASTM A48 - Standard Specification for Gray Iron Castings

3. ASTM A123 - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products

4. ASTM A148 - Standard Specification for Steel Castings, High Strength, for Structural Purposes

5. ASTM A153 - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware

6. ASTM A276 - Standard Specification for Stainless and Heat-Resisting Steel Bars and Shapes

7. ASTM A325 - Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength.

8. ASTM A536 - Standard Specification for Ductile Iron Castings

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C. American National Standards Institute (ANSI)

1. ANSI B1.1 - Unified Inch Screw Threads (UN and UNR Thread Form)
2. ANSI B16.1 - Cast Iron Pipe Flanges and Flanged Fittings.
3. ANSI 9 - Load Ratings and Fatigue Life for Ball Bearings
4. ANSI 11 - Load Ratings and Fatigue Life for Roller Bearings

D. American Gear Manufacturers Association (AGMA)

1. AGMA 250.04 - Lubrication of Industrial Enclosed Gear Drives
2. AGMA 908-B - Geometry Factors for Determining the Pitting Resistance and Bending Strength of Spur, Helical and Herringbone Gear Teeth
3. AGMA 1012 - Gear Nomenclature, Definitions of Terms with Symbols
4. AGMA 2001-C- Fundamental Rating Factors and Calculation Methods for Involute Spur and Helical Gear Teeth
5. AGMA 2004-B - Gear Materials and Heat Treatment Manual
6. AGMA 6001-C - Design and Selection of Components for Enclosed Gear Drives
7. AGMA 6010-E - Standard for Spur, Helical, Herringbone and Bevel Enclosed Drives
8. AGMA 6019-E - Gearmotors Using Spur, Helical, Herringbone, Straight Bevel or Spiral Bevel Gears
9. AGMA 6034-B- Practice for Enclosed Cylindrical Wormgear Speed Reducers and Gearmotors

E. American Institute of Steel Construction (AISC)

1. Specifications for Design, Fabrication and Erection of Structural Steel for Buildings.

F. American Iron and Steel Institute (AISI)

G. American Welding Society (AWS)

H. Anti-Friction Bearing Manufacturers Association (AFBMA)

I. National Electrical Manufacturers Association (NEMA)

J. Factory Mutual (FM)

K. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

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1.05 QUALITY ASSURANCE

A. Qualifications

1. The secondary sludge collection, scum removal equipment and the sludge withdrawal ring are intended to be standard equipment of proven ability as manufactured by a single manufacturer who is fully experienced, reputable and qualified in the manufacture of the equipment to be furnished.

2. The equipments shall be manufactured, fabricated and installed in accordance with the best practices and methods and shall operate satisfactorily when installed as shown on the Drawings.

3. The equipment supplier shall have at least 15 years experience in the design, application, and supply of circular clarifiers in wastewater treatment plants, and shall submit a list of not less than 25 operating installations of clarifiers as evidence of meeting the experience requirement. The equipment supplier shall have at least 5 operating clarifiers that are 100 feet in diameter or larger.

4. The equipments shall be by Walker Process Equipment, WesTech Engineering or approved equal.

5. Should equipment which differs from this Section be offered and determined to be equal to that specified, such equipment shall be acceptable only on the basis that any revisions in the design and/or construction of the structure, piping, appurtenant equipment, electrical work, etc, required to accommodate such a substitution shall be made at no additional cost to the Owner and be as approved by the Engineer.

B. Services of Manufacturer's Representative

1. The manufacturer shall furnish an a field service representative experienced in the erection, alignment and operation of the equipment furnished under this Section for a total of two (2) trips of not more than four (4) working days per mechanism to supervise the erection and adjustment of the equipment and to certify its readiness for operation. Each day shall include a full 8 hour working day on the project site; travel time shall be additional to these requirements.

2. The manufacturer's representative shall be present at frequent intervals to ensure proper erection and satisfactory operation of equipment. He/She shall be present at least once during each of the following times:

   a. Beginning of uncrating, assembly and installation.

   b. Final installation and alignment.

3. A factory representative who has complete knowledge of the proper operation and maintenance of the equipment furnished shall be provided (in addition to the days required above), for one 8 hour day to instruct representatives of the Owner and the Engineer on proper operation and maintenance of the equipment. An additional trip is not necessarily required, if the training can be satisfactorily scheduled as an extension of

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the installation and inspection trips, as provided above; and provided that the final operational test is successful and the operation and maintenance manuals and instructions have been furnished and approved.

C. Operating Instructions

1. Operating and maintenance instructions shall be furnished to the Engineer as provided in Section 01730. The instructions shall be prepared specifically for this installation and shall include all required cuts, drawings, equipment lists, descriptions, etc that are required to instruct operating and maintenance personnel unfamiliar with such equipment.

1.06 SYSTEM DESCRIPTION

A. The mechanisms for the clarifier shall be installed in the new circular concrete basin with an inside diameter of 100 ft and sidewater depth as shown on the Drawings. Each mechanism shall be designed to:

1. Dissipate energy and control localized currents.

2. Allow solids to separate from the clear liquid.

3. Evenly withdraw the clear liquid.

4. Transport and thicken settled sludge.

5. Prevent sludge dilution at withdrawal point.

6. Collect floating scum from the clarifier surface and discharge it to an outlet scum trough.

B. The mechanism shall be of the under-floor, center-column feed type with peripheral weir overflow to an annular discharge launder. The center column shall support the entire mechanical drive and collection equipment and the inboard end of the access bridge, which spans from the outside wall of the tank.

C. The sludge collection equipment for the new secondary clarifier shall consist of two (2) full rake arms each with two (2) inward-raking spiral blades, and two (2) stub arms, each about ½ of the radius, each with one (1) inward raking spiral blade The scraper blade rake arm assemblies shall be supported from drive cage that is directly connected to the rotating turntable, which will sweep the entire bottom of the tank. The rake arms shall clean and remove the activated sludge from the tank floor to the sludge collector ring where it will be removed by the return activated sludge pumps.

D. Influent flow in the clarifier shall be discharged from the center column through openings near the water surface directly into the EDI and influent feedwell. Flow shall then pass under the lower rim of the influent baffle into the clarification zone and eventually discharge over the peripheral overflow weir and trough. .

E. The secondary clarifier mechanism shall have two (2) surface skimmer assemblies and one (1) scum collection box. A skimmer shall be mounted on each of the long truss arms and include a full radius scum reflector blade that extends from the skimmer to the influent well.

The skimmers shall move the floating scum to the scum box and scum outlet pipe located on the side of the clarifier as shown on the drawings.

F. At average daily flow, on clarifier will handle 4.87 mgd of mixed liquor at 3,000 mg/L TSS from the aeration basins. The mixed liquor stream yields average daily surface loading of 310 gpd/ft$^2$ and 24.0 lb/ft$^2$-d.

G. At peak hourly flow, one clarifier will handle 9.43 mgd of mixed liquor at 3, 500 mg/L TSS. The mixed liquor stream yields average daily surface loading of 1200 gpd /ft$^2$ and 24.0 lb/ft$^2$-d.

H. The maximum return activated sludge (RAS) flow from each clarifier will be X.X mgd. RAS concentration will vary from 2,500 mg/L to 5,500 mg/L.

I. The collectors and drive units for the secondary clarifier shall be designed to operate at a peripheral speed of approximately 12 fpm on a continuous basis.

J. Coordinate the construction of the effluent weirs and baffles to conform to the requirements of the secondary sludge collection equipment. The Weir Plate and Scum Baffle shall be constructed as shown on the Drawings. The Weir Plate and Scum Baffle shall be constructed of ¼-in thick fiberglass reinforce plastic and shall be turquoise in color. The Weir Plate and Scum Baffle shall be attached using Type 316 stainless steel anchor bolts and washers.

K. Provide common alarm and running dry contacts as shown on the Instrumentation Drawings.

1.07 DELIVERY, STORAGE AND HANDLING

A. All parts shall be properly protected so that no damage or deterioration will occur during a prolonged delay from the time of shipment until installation is completed and the unit and equipment are ready for operation.

B. All equipment and parts must be properly protected against any damage during shipment. Store equipment shall be in accordance with manufacturer's recommendations.

1.08 MAINTENANCE

A. Spare Parts

1. Spare parts for the Secondary Clarifier shall be furnished with the equipment by the manufacturer in accordance with Section 01170. The following spare parts shall be furnished:

a. Three extra sets of all gaskets, seals, sealing strips, etc, (including felt seals for the spur gear, sludge collector arm neoprene squeegee, and scum blade seals).

b. Three PVC wear blocks or other sealing elements between the scum collector blade and the scum baffle.

c. One spare drive chain.

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d. One drive sprocket.

e. One driven sprocket.

f. Five shear pins (if used).

g. One set of heat treated bearing strip liner inserts (if used).

h. One scum skimming device complete with deflector blades and springs.

B. Special Tools

1. Provide all special tools required for normal maintenance, as well as special tools required for maintenance of the converted clarifiers, which were not required for maintenance of the original clarifiers. Tools shall be packaged in a steel case, clearly and indelibly marked on the exterior to indicate equipment for which tools are intended. Include any special equipment required to facilitate drainage or refill of lubricant.

## 1.09 WARRANTY

A. The equipment defined by this Specification shall be covered by a conventional one-year limited warranty against defects in design, materials, and workmanship. Warranty period shall commence on the date of substantial completion and shall meet the requirements of Section 01740. If any part of the equipment should fail during the warranty period, it will be replaced at no expense to the Owner.

# PART 2 PRODUCTS

## 2.01 MATERIALS AND EQUIPMENT

A. This Section calls attention to certain features, but does not purport to cover all details of construction of the units.

B. All equipment shall be assembled in the manufacturer's shop as far as practical to ensure proper fitting of parts, then match-marked for erection and disassembled for shipment. All field connections shall be bolted connections sized and arranged to resist all static, live and erection loads. Field welded assembly, except for the bridge splice and rake/cage final connection, shall not be allowed unless approved by the Engineer in writing.

C. The equipment shall be constructed so that there will be no chains, sprockets, bearings or operating mechanism below the liquid surface or in contact with the liquid. The entire drive assembly shall be installed sufficiently above the liquid surface, so that the drive assembly will not be affected by any foaming or splashing in the influent feedwell.

D. All structural steel used in the fabrication of the mechanisms shall conform to the requirements of ASTM A36. Selection and fabrication of structural steel members shall be in accordance with the AISC Specifications for the Design Fabrication and Erection of Structural Steel for Buildings. All welding shall conform to the latest standards of AWS. All structural steel shall have a minimum thickness of 1/4-in, except as otherwise noted.

E. The center drive mechanism shall consist of a motor driven primary gear reduction unit, steel chain roller drive, shear pin coupling, intermediate worm gear reduction unit, enclosed final

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gear reduction unit, and an overload system. Drive assemblies shall be completely factory assembled and shipped as complete units. The drive unit shall be supplied by the clarifier equipment supplier to ensure unit responsibility. The continuous output torque rating and the allowable stress values used in the design of the intermediate worm gear reduction unit and the final gear reduction unit shall be in **strict** conformance with the latest revision of the following standards:

**Worm & Worm Gearing**: ANSI/AGMA 6034-B92, "Practice for Enclosed Cylindrical Worm gear Speed Reducers and Gearmotors."

**Spur and Pinion Gearing:** ANSI/AGMA 2001-C95, "Fundamental Rating Factors and Calculation Methods for Involute Spur and Helical Gear Teeth."

1. The continuous output torque rating of the spur and pinion gearing shall be based on the smaller of the rating values determined from the above ANSI/AGMA standard and a design life of 20 years. The drive shall be designed and rated to develop the following torque values:

| OPERATING CONDITION | FOOT-POUNDS | NOTES |
|---|---|---|
| CONTINUOUS | 150,000 | |
| ALARM | 150,000 | 100% OF CONTINUOUS |
| MOTOR CUT-OFF | 180,000 | 120% OF CONTINUOUS |
| MOMENTARY PEAK | 300,000 | 200% OF CONTINUOUS |
| SHEAR PIN | 260,000 | LESS THAN 200% OF CONTINUOUS |

The equipment manufacturer shall submit calculations to the ENGINEER for approval substantiating the continuous output torque rating and design life. Calculations shall include the spur gear, pinion, worm gear set, and all bearings used in the intermediate worm gear reduction unit and the final gear reduction unit.

The spur gear and pinion calculations shall clearly specify the values used for the following design parameters for surface durability and strength ratings:

| | |
|---|---|
| Number of Pinions | Pinion Pitch Diameter |
| Actual Face Width | Tooth Diametrical Pitch |
| Tooth Geometry Factors (I & J Factors) | Hardness Ratio Factor |
| Load Distribution Factor | Elastic Coefficient |
| Aspect Ratio | Life Factor |
| Allowable Contact Stress | Application Factor |
| Allowable Bending Stress | Rim Thickness Factor |

Load distribution factors (Cm and Km) used in the calculations shall not exceed 1.28. For parameters that are material dependent, such as allowable contact stress, the calculations shall include a full description of the materials, quality grade, and heat treatment used. Momentary peak torque calculations shall use a maximum of 75% of yield strength.

2. The primary gear reduction unit shall consist of a totally enclosed, horizontal type gearmotor or gear reducer with C-face mounted drive motor, mounted on top of the intermediate worm gear housing. The primary gear reduction unit shall be a heavy-duty

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parallel shaft helical type. Gearmotors shall conform to ANSI/AGMA 600009-A00, and shall have a service factor of 1.4, based upon the specified continuous running torque. Gear reducers with a C-face mounted drive motor shall conform to ANSI/AGMA 6010-F97 and shall have a service factor of 1.25. All gearbox bearings shall be of the anti-friction type and running in oil in a cast iron or steel housing. The totally enclosed primary reduction unit shall operate on 3 phase, 60 hertz, 460 volt power source, and shall be at least 1.5 HP. The motor shall conform to NEMA specifications for AC motors and be designed for continuous operating in humid outdoor condition. The motor shall be totally enclosed for outdoor service and shall conform to motor standards in Section 16150. The motor shall be sized such that the name plate horsepower rating shall not be exceeded if the mechanism operates at the stalled torque.

3. Power transmission between the primary gear reduction unit and the intermediate worm gear reduction unit shall be through a steel roller chain and steel sprocket assembly. The driven sprocket shall include a shear pin overload to provide overload protection to the drive train. The chain drive shall be enclosed with a fiberglass chain guard meeting OSHA requirements. The shear pin overload shall be easily accessible by removal of the chain guard. Direct drives, in lieu of a chain drive, will **not** be acceptable.

4. The intermediate worm gear reduction unit shall consist of a worm gear driven by an integral straddle mounted worm and shaft, supported by heavy-duty anti-friction bearings running in an oil bath, and housing. Shell worms will **not** be acceptable. Plain or sleeve type bearings will **not** be acceptable. All bearings shall have a minimum L10 life of 20 years, based on the continuous torque rating.

   a. The integral worm and shaft shall be single piece and made from AISI 8620 alloy steel carburized, hardened and ground and shall have a case hardness of minimum 58 Rc. The worm gear shall be centrifugally cast, conforming to ASTM B271 and ANSI/AGMA 2004-B89, high strength, manganese bronze. The worm gear shall have a minimum 200 Brinnel hardness. The worm gear shall be keyed to the pinion shaft. The intermediate worm gear housing shall be ASTM A48 Class 40 cast iron complete with seals, oil fill, oil level sight gauge and drain plugs. The intermediate worm gear housing shall have **full** 360° contact and support from the final gear housing. Fabricated housings will **not** be acceptable.

5. The final gear reduction unit shall consist of a pinion, internal split spur gear, anti-friction ball bearing assembly, and housing.

   a. The pinion shall be AISI 4150 minimum grade 2 steel, heat treated to a minimum 321 BHN hardness. The pinion shall be single piece, extending from the worm gear to the spur gear, straddle mounted between anti-friction ball or roller bearings to maintain accurate pinion to spur gear alignment and contact. All bearings shall have a minimum L10 life of 20 years based on the continuous torque. Overhung pinions shall **not** be acceptable. The pinion shall be manufactured to have a minimum AGMA quality class 8, in conformance with ANSI/AGMA 2000-A88.

6. The internal spur gear shall be ductile iron normalized, quenched & tempered, conforming to grade 120-90-02, with micro-structure of fine tempered pearlier, conforming to ASTM A536, manufactured to have a minimum base hardness of 270 BHN and have a minimum AGMA quality Class 6, in conformance with ANSI/AGMA 2000-A88. The spur gear shall

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have a minimum 80-inch pitch diameter and have a minimum 5.5-inch face width. The internal spur gear shall be of split construction to provide for replacement of balls and race inserts without removing the drive unit or other parts of the clarifier mechanism. Internal spur gears lacking split construction will **not** be acceptable.

7. The internal spur gear shall be mounted on a large, full compliment anti-friction ball bearing assembly designed to support the entire rotating clarifier mechanism. The ball bearing assembly shall consist of 1-1/2" diameter AISI E52100 GRADE 50 chrome alloy steel bearing balls (60-64 Rc) running in an oil bath protected from contamination by a dust shield. Spacer balls will **not** be acceptable. The balls shall bear both horizontally and vertically on four (4) renewable hardened alloy steel race inserts inserted into the housing and the internal spur gear. The minimum ball race diameter shall be 85-inches, to assure stability. The race liner inserts shall be heat-treated to a hardness of no greater than 43-48 Rc to avoid fatigue cracking. The race inserts and bearing balls shall be designed for a minimum L10 life of 20 years. Bearing life calculations shall include all **combined** horizontal and vertical loads on the bearing assembly. Four point angular contact bearings will **not** be acceptable.

   a. Bearing race wear shall be capable of being measured without disassembly of the bearing or drive and without dewatering the collector basin. Bearing designs in which bearing wear cannot be measured or which require the disassembly of the bearing or final gear reduction or dewatering of the collector basin in order to measure bearing wear will not be acceptable.

8. The ball bearing assembly shall be mounted in ASTM A48 Class 40 cast iron housing. The housing shall be cast as a single piece to provide a leak proof enclosure. Fabricated housings will **not** be acceptable. Seals or gaskets located below the oil level will **not** be acceptable. The base of the housing shall be mounted on the top flange of the stationary center column and designed to support the internal spur gear, the rotating clarifier mechanism, and one end of the access bridge. The housing shall be complete with seals, oil level dipstick, oil fill, and valved oil and condensation drains. A positive means of removing condensation and contaminant from the lower pinion-bearing pocket shall be provided.

   a. The condensate removal system shall automatically drain condensate from the lowest points of the housing as the condensate accumulates without operator attendance. The system shall accommodate changes of lubricant specific gravity through a slip coupling in the discharge portion of the system in order to maintain the system in equilibrium. The system shall not be adversely affected by evaporation of water from the system and shall have a positive means to prevent loss of water from the positive sealing of the system discharge when condensate is not being drained. The Walker Process Equipment condensate removal system is described in US Patent Number US 6,926,022 B2.

   b. Lubrication of the gear teeth shall be accomplished by means of an oil dam and the meshing action of the pinion and the internal gear teeth that shall force lubricant up the face of the teeth. Designs that require auxiliary oil pumps or circulating systems for lubrication will **not** be acceptable.

9. The condensate removal system shall automatically drain condensate from the lowest points of the housing as the condensate accumulates without operator attendance. The system shall accommodate changes of lubricant specific gravity through a slip coupling

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in the discharge portion of the system in order to maintain the system in equilibrium. The system shall not be adversely affected by evaporation of water from the system and shall have a positive means to prevent loss of water from the system due to evaporation of condensate from the system discharge by positive sealing of the system discharge when condensate is not being drained.

a. The contractor shall furnish heat trace tape and insulation for the exposed portions of the condensate system. The operation of the heat trace tape shall be controlled by a thermostatic switch set to energy the heat trace tape when the ambient temperature falls below 38°F.

b. Condensate removal systems that are affected by evaporation, differences in lubricant specific gravities, or that require manual operation are not acceptable.

10. The overload protection system shall include a totally enclosed actuator and visual load indicator plainly showing the overload points. Non-enclosed actuator systems will **not** be acceptable. The overload alarm and shut-off system shall consist of two (2) SPDT micro switches, one to close an alarm circuit when the load reaches the alarm running torque of the drive assembly, and one to cut off the motor when the load reaches the cut-off running torque of the drive assembly. The micro switches shall be mounted in a watertight housing and shall be actuated by the movement of the worm shaft in the intermediate worm gear speed reducer. A Plexiglas window shall be mounted on the overload housing for observance of the dial position. Shear pins shall provide additional protection above the cut-off point.

a. The overload warning switch shall be pre-set at the factory to allow the transmission of a remote signal in case of impending excessive load. The switch shall be set to energize an alarm in the case of impending excessive load over a field adjustable range of 75 to 100 percent of the maximum continuous working output.

b. The shut down switch shall be pre-set at the factory to allow the transmission of a remote signal in case of impending excessive load. The switch shall be set to energize an alarm in the case of impending excessive load over a field adjustable range of 100 to 180 percent of the maximum continuous working output.

c. Provide dry contacts rated 10 Amps at 120 VAC for remote control of alarms. Provide one NO contact for overload warning, and one NO contact for overload alarm.

d. The clarifier manufacturer shall supply a control panel to be mounted by the contractor as depicted on plan sheet EH-2, and as designed and described in notes on plan sheet EY-7A. The panel will include circuitry to interlock operation of the clarifier scum spray-down nozzle system with the rake sweep limit switch shown on plan sheet P-1 and EH-2.

11. The access truss type bridge shall extend from the tank sidewall to the operating platform. The bridge shall be supported at the tank sidewall and the turntable base. One endbearing member of the bridge shall slide. The bridge shall be oriented as shown on the Drawings. The access bridge shall consist of beams or channels. The access bridge walkway deck shall be aluminum grating at lease 36-in. wide inside the handrails. The access bridge shall be verified to be designed for a superimposed loading of 100 lbs/sq.

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ft. Deflection of the access bridge under this load shall not exceed 1/360 of the span. The access bridge shall have an operating platform at the turntable base of skid proof 3/8-in. thick aluminum or 1/4-in. Type 304 stainless steel checkered plate and shall provide a walkway space at least 2-ft. wide clearance on all sides of the center drive unit. Aluminum handrailing with a 4-inch toeboard shall be attached to all sides of the center platform and around the drive opening. Handrails shall be 1 ½" diameter aluminum handrails in accordance with OSHA standards.

F. Each center column shall support the entire sludge collector mechanism. Center column shall be constructed from 1/4-in thick (minimum) steel plate suitably reinforced where necessary and designed to withstand the stalled torque of the drive assembly. The center column shall have a diameter of 42-in to secure low inlet velocity into the energy dissipating influent well. The center column shall be mounted over the concrete influent port at the center of the tank and have six outlets at its upper end to disperse the influent flow into the tank. The outlets shall be 13-inches wide and 30-inches tall and be evenly spaced around the column. The top of the ports shall be set at 3-inches above the maximum water level indicated on the drawings. One 20-in circular bolted inspection and access hatch shall be provided on the center column above the return sludge manifold.

1. The center column shall be mounted over the influent port at the center of the tank. The bottom of the center column shall have bolting flange for anchorage to the concrete tank. The equipment manufacturer shall furnish a template to locate the anchor bolts for the center column. Anchor bolts shall be provided to ensure complete rigidity of the sludge collector equipment to the concrete. Anchor bolts shall be of Type 304 stainless steel.

2. The top of each center column shall have outlet ports to disperse the influent into the tanks near the water surface. The dimensions of the center column for all clarifiers are shown on the Drawings.

3. The top of each center column shall be provided with a mounting plate to provide an accurate fit of the drive assembly and allow the drive assembly to be accurately positioned, shimmed and leveled. The drive assembly and shall be attached with Type 304 stainless steel bolts or machine screws.

G. The influent feedwell shall efficiently and evenly disperse the influent liquid into the tank without disturbance and provide a flocculation zone. The dimensions of the influent feedwell are shown on the Drawings.

1. Feedwell shall be constructed of minimum 3/16-in thick type 304 stainless steel plate suitably reinforced with a top rim angle and vertical stiffening angles. The feedwell shall be a non-rotating type supported by structural support system above the water level. Provisions shall be made for the continuous or periodic removal of scum and floating material from inside the feedwell without allowing short circuiting. The above provision shall take the form of slots complete with baffles, which shall be accessible from the platform.

2. Energy Dissipating Inlet (E.D.I.): A rotating circular energy dissipating inlet with bottom shall be supported by the cage and be designed to diffuse the liquid into the feedwell in a tangential direction without excessive disturbance or formation of vertical velocity currents. The E.D.I. shall be designed to positively prevent sludge from depositing within the E.D.I. and shall include bottom drain holes. The dimensions of the E.D.I. are shown

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on the Drawings. The EDI shall be constructed of minimum 3/16" thick type 304 stainless steel plate suitably reinforced with stiffening angles.

H. The center drive cage shall be of a box truss all-welded construction of structural steel having minimum plate thickness of 1/4-in. Center drive cage shall be fastened to the turntable base and main spur gear assembly with Type 304 stainless steel machine screws or a high strength bolted connection. The center drive cage shall support and rotate the 4 collector arm assemblies, the rotating section of the sludge collecting boxes and the scum removal device. The center drive cage assembly shall have sufficient strength and rigidity that no member will be stressed beyond the allowable limits set forth in the AISC standards. The rake arms shall be connected to the center drive cage with heavy pinned connections that include clevis rod assemblies for final adjustment of the arms. Pins and clevis mechanisms shall be hot dipped galvanized.

I. The sludge collection mechanisms shall have two long structural steel rake collector arms, located 180 degrees apart, rigidly connected to the center drive cage. The rake collector arms shall be of a steel truss construction, rectangular or triangular, conforming to the slope of the tank floor and shall extend from the center drive cage to the inside face of the outer wall of the tank. The two long rake collector arms shall extend to the radius of the clarifier, less the requirement for scum baffles.

1. The rake collector arm shall be provided with two inward raking spiral-shaped steel blades to scrape the collected sludge along the tank bottom to the sludge collector ring located near the center of the tank.

2. To ensure alignment and connection to the center drive cage, the width of the rake collector arms shall be approximately the same as the center drive cage. The rake arms shall be connected to the center drive cage in such a manner that each arm can be easily removed completely or adjusted to conform to the angle of the tank floor. Furnish shims as necessary to adjust rake arm angle. The arms shall not incorporate the use of tie rods or yoke connections.

3. The blade setting shall be similar for each rake collector arm with the blades spaced so that the entire circular portion of the tank bottom will be scraped twice with each revolution of the mechanism.

4. All scraper blades shall be provided with adjustable spring brass or Type 304 stainless steel squeegees projecting approximately 1-1/2-in below the bottom of the blade and secured by Type 304 stainless steel bolts and nuts. Each squeegee shall have a minimum thickness of 26 gauge and be designed for a 2-in minimum adjustment in the vertical plane. Scraper blades shall be designed for sufficient sludge transport capacity to handle the design solids loading rate, with the depth of the blade varying from a minimum at the tank periphery to a maximum at the tank center. Blades shall properly convey settled sludge to the sludge hopper. The rake speed shall be sufficient to transport the necessary volume of sludge to the sludge outlet, but shall not re-suspend settled sludge.

5. Components of the rake collector arms shall be constructed from 1/4-in thick (minimum) steel plate and angle, suitably reinforced such that no portion of the rake arm will be stressed beyond the allowable limits set forth in the AISC standards when the full stall torque load of the drive assembly is applied as a distributed load on one of the rake arms.

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J. The clarifier shall have a sludge withdrawal ring located and sized to prevent short-circuiting of the influent mixed liquor to the underflow. The ring shall be placed at a point of high sludge concentration. It shall be placed as shown on the Drawings and shall remove sludge uniformly around the center of the tank.

1. The sludge withdrawal ring shall be of the standard design supplied by the named manufacturers or approved equal. The Drawings illustrate one type of sludge ring design but do not relieve the manufacture from the responsibility to design, size, and install a sludge ring appropriate for the intended end use. The tank floor slope and Secondary Sludge Withdrawal Ring design shall be verified by the clarifier equipment manufacturer. The sludge withdrawal ring shall be constructed of ¼-inch or thicker type 304 stainless steel plate. The sludge withdrawal ring shall surround the center column and shall include appropriate anchorage.

K. A scum removal device shall be provided to move and remove any floating scum from the entire tank's water surface to one fabricated steel outlet scum trough located on the weir wall of the discharge launder as shown on the Drawings. The scum removal device shall consist of two scum collecting arms and a scum trough. Each scum collecting arm shall have a tangential scum deflector blade; support boom; and a hinged blade with neoprene strips on the bottom and inner edges to seal the entrapped scum and water when discharging into the scum trough. At the end of the deflector blade where the hinged blades are located, provide a scum pocket to trap scum that has been channeled by the deflector blade to the end of the scum arm. The scum pocket shall have the same width as the scum trough and shall be at least 9-inch deep (plan view). The hinged blade shall protect the scum removal device from damage in the winter when scum may freeze in the scum trough. The scum removal mechanism shall be supported by structural steel members bolted through field adjustable connections to the long rake collector arms and shall extend from the flocculating feedwell to the scum baffle on the effluent launder. In order to facilitate the channeling of scum to the scum trough, the blade shall be set at a 2 degree angle. The scum deflector blade shall be designed such that it can be removed without taking the basin out of service. A replaceable PVC wear block or neoprene wiper strip shall be provided on the outer edge of each hinged blade. The wear block shall be constantly forced against the scum baffle by a coiled spring arrangement to effectively keep the scum baffle clean. The force between the scum baffle and the PVC wear block shall be adjustable and in the range of 1 to 5 lbs.

1. The coiled springs shall be enclosed in a cast iron or welded steel housing to protect them from the weather and the housing shall be bronze bushed and oil or grease lubricated for easy movement of the hinged blades. Alternatively, springs may be of Type 316 stainless steel and not housed. The hinged blades shall be adjustable so that the quantity of liquid discharged with the scum can be varied and shall be so designed that the blades can move in a vertical plane so that the bottom edge of the blades is always in contact with the scum trough even if the trough is not horizontal.

2. The scum trough and scum beach shall be fabricated from 1/4-in thick type 304 stainless steel plate and supported from the tank wall and effluent launder channel wall by structural steel braces. The scum trough shall have a radial dimension of at least 10'-0" and have a minimum length of 6'-0" along the scum baffle. The scum trough shall have a 8-in diameter standard pipe flange connection, located as indicated on the Drawings for the scum discharge pipe. The inclined approach beach shall be shaped to contain the scum as it is moved up the incline to the trough by the hinged blade. The beach shall be constructed to provide a 4-in adjustment in elevation. Adjustment shall be by means of

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adjustable Type 316 stainless steel bolts using nuts and elongated slots on the approach beach. Gaskets of a suitable material shall be provided to prevent leakage between the approach beach and the discharge section of the scum trough.

3. The outer edge of each scum trough shall extend to form an extra deep scum baffle to prevent spillage of scum to the effluent launder.

2.02 SURFACE PREPARATION AND SHOP PRIME PAINTING

A. Surface preparation and shop prime painting shall be part of the work of this Section and shall be as specified in Section 09901 and 09902. Aluminum and stainless steel surfaces shall not require painting.

B. All ferrous surfaces not otherwise specified to be stainless steel shall be delivered to the jobsite hot-dip galvanized.

C. The spur drive assembly shall be shop prime painted with one (1) coat of the clarifier manufacturer's standard epoxy primer and ready for field coating in the field. The factory finish of the motor and primary gear reducer will not require additional shop or field coating.

D. Excluding the stainless steel components, the spur gear, the primary gear reducer, and the motor, all other components of the clarifier mechanism shall be hot dipped galvanized. Prior to the hot dip galvanized process, each component will be completely submerged and thoroughly cleaned in a pickling vat. Field touch-up of scratches, marks, bruises or field cuts shall be made in accordance with Specification Section 09902, 2.02.C.5 and 7.

E. Field touch-up of scratch marks and bruises to shop applied coatings and finish painting shall be furnished and applied by the contractor in accordance with Specification Sections 09901 and 09902.

PART 3 EXECUTION

3.01 PREPARATION

A. Install all equipment in strict accordance with the manufacturer's recommendations. Make all necessary adjustments to new and existing equipment in order to provide complete and satisfactory operation upon completion of the Contract.

B. Surfaces of clarifier members that will be inaccessible after fabrication shall be prepared in accordance with Specification Section 09901 and be seal welded to isolate these inaccessible surface areas from exposure to weather or corrosive environment. As an alternative, the inaccessible surfaces may be prepared and painted in accordance with Section 09901 and 09902 before fabrication. Equipment manufacturer shall submit to Engineer, for approval, the proposed method of corrosion prevention for the referenced inaccessible surfaces.

3.02 INSTALLATION

A. Installation shall be in strict accordance with the respective manufacturer's instructions and recommendations in the locations shown on the Drawings. Installation shall include furnishing the required oil or grease for initial operation. The grades of oil and grease shall be in accordance with the manufacturer's recommendations. Anchor bolts shall be furnished

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by the equipment manufacturer and set in accordance with the manufacturer's recommendations.

B. Submit a certificate from the manufacturer stating that the installed equipment has been examined and found to be in complete accordance with the manufacturer's requirements, that the equipment is ready for operation and that the operating personnel have been suitably instructed in the operation, lubrication and care of the equipment.

3.03 FIELD TESTING

A. Furnish the services of a factory representative as specified in PART 1 to inspect the final installation and supervise a test run of the equipment.

B. Working under the direction of the manufacturer and Engineer, perform field tests as follows:

1. A torque test shall be conducted prior to placement of the cement mortar finish of the floors in the new secondary clarifiers.

2. Anchor bolts furnished by the equipment manufacturer shall be embedded in the concrete floor at points near the outer portion of the rake arms. The anchor bolts shall be suitable for the loads applied and shall be cut off flush with the rough concrete surface after the tests are completed. The bolts shall be arranged so that a single cable shall be used at the apex of the cables connecting panel points of the rake arms. A hydraulic cylinder of sufficient capacity with a known piston diameter, complete with pressure gauge, shall be connected to the anchor bolts to determine the horizontal load developed. The required gauge reading shall be such that the gauge indicates a force at the anchor bolts, which, when multiplied by the distance from the center of the tank to the anchor bolts, will equal twice the specified maximum continuous working output torque. This force shall be maintained for a period of 15 seconds duration to assure that the equipment is capable of withstanding the required loading under static test conditions (i.e., without the drive motor in operation) and to verify or correct the setting of the overload device prior to the actual testing of the equipment with the drive motor. Also adjust the over load warning torque setting specified in PART 2. Alternative methods of producing the required torque will be considered. Details of any alternative test procedures shall be submitted to the Engineer for approval. Test methods shall not apply impact loading or jerky loading conditions to the mechanism, which may reduce the life of the equipment.

3. After the above test and adjustments and settings to the overload device have been made, the drive motor shall be switched on and the mechanism loaded to overload condition to ensure that the sludge collector mechanism will alarm, then stop when a predetermined overload condition occurs in the tank.

4. Upon completion of the static and operating torque tests, the mechanism shall be run dry for a period of 8 hours and shall operate without vibration, noise, jamming, or over heating. Special attention shall be given during the dry test run of the equipment for the operation of the scum removal device.

5. The tests shall be conducted in the presence of the Engineer. All power, water, equipment and appurtenances required for testing shall be furnished.

6. In the event the mechanisms fail to meet the above test, the necessary changes shall be

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made and the mechanisms retested. If the mechanisms remain unable to meet the test requirements to the satisfaction of the Engineer, they shall be removed and replaced with satisfactory mechanisms at no expense to the Owner.

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SECTION 11357

# FIBERGLASS WEIRS, STAMFORD BAFFLES AND TROUGHS

## PART 1 GENERAL

### 1.01 SCOPE OF WORK

A. Furnish all labor, materials, equipment and incidentals required to design, manufacture, and install, complete and ready for operation, and field test all weirs, scum baffles, Stamford Baffles, troughs, supports, fasteners, closures, sealants and butt plates of the sizes, shapes and the quantities as shown on the Drawings and as specified herein.

### 1.02 RELATED WORK

A. Concrete is included in Division 03.

B. Miscellaneous metals are included in Division 05.

C. Mechanical piping is included in Division 15.

### 1.03 SUBMITTALS

A. Submit, in accordance with Section 01 33 00, copies of all materials required to establish compliance with this Section. Submittals shall include the following:

1. Dimensions of all components.

2. Complete installation instructions.

3. Complete description of materials and resins used, including physical properties and methods of manufacture for the fiberglass weirs.

4. Certification that materials of fiberglass reinforced polyester are resistant to chemical attack from sewage and chemicals.

5. Statement that fabrication is in accordance with this Section.

6. Complete bill of materials.

7. Complete assembly drawings.

8. For the SECONDARY CLARIFIER EFFLUENT TROUGHS, AND THE AERATION EFFLUENT TROUGHS, and AERATION BASIN DISTRIBUTION STRUCUTURE. Third party certified support calculations, stamped by a professional engineer registered in the State of Arkansas, shall be submitted for information only.

9. Submit certified test reports of manufactured laminates, as specified herein. Submit one 6-in by 6-in by 1/4-in sample of polyester laminate to be used in the weirs and supports and one 6-in long actual weir with anchor bolt hole.

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B. Operating and Maintenance Data

1. Operating and maintenance instructions shall be furnished as provided in Section 01730. The instructions shall be prepared specifically for this installation and shall include all required cuts, drawings, descriptions that are required to instruct operating and maintenance personnel unfamiliar with such equipment. The maintenance instructions shall include full preventive maintenance schedules.

1.04 REFERENCE STANDARDS

A. American Society for Testing and Materials (ASTM)

1. ASTM A276 - Standard Specification for Stainless Steel Bars and Shapes.

2. ASTM D256 - Standard Test Methods for Determining the Pendulum Impact Resistance of Notched Specimens of Plastics.

3. ASTM D570 - Standard Test Method for Water Absorption of Plastics.

4. ASTM D638 - Standard Test Method for Tensile Properties of Plastics.

5. ASTM D790 - Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.

6. ASTM D2583 - Standard Test Method for Indentation Hardness of Rigid Plastics by Means of a Barcol Impressor

B. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.05 QUALITY ASSURANCE

A. All fiberglass weirs, troughs, Stamford Baffles, supports, fasteners, anchor bolts, etc shall be furnished and designed from a single manufacturer who is fully experienced, reputable and qualified in the design and fabrication of such equipment.

B. Design loads for water differentials for troughs and associated supports and brackets are assumed to be an empty tank with a completely full trough and a completely full tank with a completely empty trough. Required factor of safety is 2.0. Full scale testing shall be performed to insure that the materials meet all requirements.

C. All fiberglass weirs, troughs, Stamford Baffles, supports, fasteners, and anchor bolts, etc shall be designed to resist flotation.

1.06 SYSTEM DESCRIPTION

A. Secondary Clarifiers, Aeration Basin, and Aeration Basin Distribution Structure

1. Effluent troughs and scum baffles for the primary clarifiers shall be of fiberglass reinforced polyester (FRP) resin designed and constructed to the dimensions shown on the Drawings.

2. Support brackets for the scum baffles shall be of either FRP resin or stainless steel with stainless steel hardware designed and constructed to the dimensions shown on the Drawings.

3. Support brackets and supporting structure for the effluent troughs shall be Type 316 stainless steel with stainless steel hardware designed and constructed to the dimensions shown on the Drawings.

4. Troughs and supporting brackets shall be designed in accordance with the criteria specified in Paragraph 1.05.

5. V-notch weirs and vertical scum baffles, for the secondary clarifiers shall be of FRP resin with stainless steel hardware constructed to the dimensions shown on the Drawings. Support brackets for the vertical scum baffles shall be of fiberglass reinforced polyester resin or Type 316 stainless steel.

6. Horizontal baffles (Stamford Baffles), for the secondary clarifiers shall be of FRP resin with stainless steel hardware constructed to the dimensions shown on the Drawings. Baffles and supporting brackets shall be designed in accordance with the criteria specified in Paragraph 1.05.

## 1.07 MAINTENANCE

A. Spare Parts

1. All spare parts required for normal operation and maintenance of the equipment shall be furnished in accordance with Section 01730.

2. As a minimum, the following spare parts shall be furnished:

a. Five percent of the total number of installed weir plates and scum baffle plates. Included shall be a sufficient number of washers, nuts and caulking compound for installation of the spare weirs and baffles.

3. All spare parts shall be suitably packaged and clearly identified with indelible markings on the containers.

# PART 2 PRODUCTS

## 2.01 FIBERGLASS WEIRS, BAFFLES, STAMFORD BAFFLES AND TROUGHS

A. Fiberglass weirs, baffles, scum baffles, Stamford Baffles, and supports shall be Leo-Lite 87 by F. B. Leopold Company, Inc., Zelienople, PA, similar by Warminster Fiberglass Co., Southampton, PA or equal.

B. Weirs, scum baffles, Stamford baffles and troughs shall be fabricated in accordance with ANSI/AWWA F102.

C. Weirs, scum baffles, Stamford baffles and troughs produced from fabricated plate stock with cut edges, notches, etc, will not be acceptable.

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D. All weir plates, scum baffle plates, Stamford baffles, effluent troughs, butt plates, washers and vertical scum baffle support brackets shall be fiberglass reinforced polyester plastic molded by the matched die method to produce uniform, smooth surfaces. All surfaces shall be smooth, resin rich, free of voids and porosity, without dry spots, crazes, or unreinforced areas and shall provide for increased corrosion resistance and weathering. Alternatively, scum baffle support brackets may be of Type 316 stainless steel. The aeration tank trough supports shall be of Type 316 stainless steel.

E. Laminate shall contain ultra-violet inhibitors added to protect the laminate from deterioration from sunlight. Laminate shall contain a glass content of 30 plus/minus 2 percent using Type "E" glass with chrome or silane finish. Powdered reinforcements shall consist of 47.5 plus/ minus 1 percent of resin mixture. Final laminate thickness shall be within plus/minus 10 percent of the nominal specified thickness.

F. Manufacturer shall maintain a continuous quality control program and shall furnish the Engineer with certified test reports consisting of physical tests of samples as listed below and otherwise as required to show quality of plastic being furnished.

G. Hardness test shall be made with the resin-rich surface of the product. Flexural tests shall be made with the resin rich surface in compression. Test samples shall be full thickness of the item produced and shall not be machined on the surface.

H. Procedure to be used in determining the properties listed in the following tables shall be in accordance with the following ASTM Standards: ASTM D638, ASTM D790, ASTM D256, and ASTM D570.

I. Minimum physical properties at a temperature of 70 degrees F for the plastic shall be as follows:

1. For all fiberglass weirs, baffles and troughs Tensile Strength - 14,000 psi; Flexural Strength - 25,000 psi; Flexural Modulus - 800,000 psi; Impact, Notches, Izod foot pound per inch - 13.5; Barcol Hardness minimum - 35.

2. Average coefficient of thermal expansion - inch per inch, per degree F - .000016; Water absorption, percent 24 hours - 0.2.

J. The weir plates, baffle plates, Stamford baffles and supports shall be plastic laminate that is 1/4-in thick and molded to the sizes and shapes as shown on the Drawings. Oversize mounting holes shall be provided on 12-in centers on the weir plate plastic laminate for vertical and horizontal adjustment of at least 1-in plus/minus. Cut ends of non-standard lengths of weirs and baffles shall be resin sealed. Weir plates shall be provided with molded V-notches of the dimensions shown on the Drawings.

K. Anchor bolts, bolts, nuts, washers, and other hardware shall be stainless steel in accordance with ASTM A276, Type 316.

L. Caulking compound shall be an acrylic polymer or a two part sealant equal or exceeding Federal Spec. TT-S227B.

M. The vertical scum baffle and supports shall be designed to withstand the constant forces exerted on it by the scum skimming mechanisms of the secondary clarifiers and gravity thickener.

N. All required supports, columns, brackets, anchor bolts and miscellaneous hardware shall be designed, fabricated, and provided by the manufacturer.

2.02 SURFACE PREPARATION AND SHOP PRIME PAINTING

A. All ferrous surfaces shall receive surface preparation and shop prime painting in accordance with Section 09 91 10 as part of the work of this Section.

PART 3 EXECUTION

3.01 INSTALLATION

A. Installation shall be in strict accordance with the manufacturer's instructions and recommendations, by mechanics skilled in the installation of this type of work, in the locations shown on the Drawings. Anchor bolts shall be furnished by the manufacturer and set in accordance with the manufacturer's recommendations.

B. Weirs and baffles shall be carefully aligned and leveled to the elevations shown on the Drawings. In the completed installation, no variation greater than 1/8-in shall exist between any two notches of the weir plate in any one tank. In addition, the average deviation from one quadrant of the weir to any other shall not exceed 1/16-in. Caulking compound shall be used to completely prevent flow of liquid up between the concrete weir wall and the weir plate.

C. Scum baffles shall be coordinated with the secondary scum boxes from the equipment supplier to assure the proper action of the skimming blade to collect and discharge of scum to the boxes.

3.02 FIELD INSPECTION AND TESTING

A. Furnish the services of a factory representative for 2 days, who has complete knowledge of proper installation, startup and operation of the weirs and baffles to inspect the final installation and supervise a test run of the equipment. If there are difficulties in operation of the equipment due to the manufacturer's fabrication or Contractor's installation, additional service shall be provided at no additional cost to the Owner.

B. Upon completion of installation, fill each tank with water to observe the leveling of the weir plates and shall operate the sludge collector mechanism to demonstrate proper installation of the skimmer and weir brush with the weirs and baffles. Furnish all labor and materials for such tests and correct defects in the fabrication and installation. Weirs and baffles exhibiting excessive deflection, as determined by the Engineer, shall be removed and replaced at no additional cost to the Owner.

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# SECTION 11370

# LARGE BUBBLE COMPRESSED AIR MIXING SYSTEM

## PART 1 GENERAL

### 1.01 SCOPE OF WORK

A. Furnish all labor, materials, equipment and incidentals required, and install a large bubble compressed air mixing system for the purpose of mixing anaerobic and anoxic basins as shown on the Drawings and as specified herein.

B. The air mixing system shall be provided complete with all accessories, special tools, and spare parts required for a complete and operable system.

C. The Contractor shall provide suitable air line piping and fittings to the air mixing system Valve Control Panels (VCPs) as shown on the drawings and as further specified. The air mixing system manufacturer shall provide suitable air line piping, hose, headers, and nozzles from the VCPs into each basin.

D. The Contractor shall furnish, install, test, and place into satisfactory operation the compressed air system as specified herein and shown on the Drawings.

E. The compressed air system shall include a factory packaged air compressor with air receiver, air dryer, controls, and all accessories and appurtenances specified, indicated on the drawings, or otherwise required for a complete, properly operating installation.

### 1.02 RELATED WORK

A. General Requirements are included in Division 1.

B. Steel Piping is included in Division 15.

C. Maintenance of Plant operation and Sequence of Construction is included in Division 1.

D. Demolition is included in Section 02050.

E. Concrete work is included in Division 3.

F. Instrumentation is included in Division 13.

G. Piping, valves, and appurtenances other than those herein are included in the respective sections of Division 15.

H. Electrical work not specified herein is included in Division 16.

### 1.03 SUBMITTALS

A. The Contractor shall submit Shop Drawings, Operation and Maintenance Instructions, and other information as specified in accordance with Section 01300. Shop Drawings shall also include complete erection, installation, and adjustment instructions and recommendations.

B. For the Compressed Air Mixing System, in addition to the submittal requirements specified in Section 01300, submit the following:

1. Compressor support locations and loads that will be transmitted to bases and foundations.

2. Complete electrical schematics and field termination drawings.

3. Complete assembly and installation drawings including overall equipment layout and piping interconnection drawings by the Contractor.

4. Compressor field test results.

5. Detailed specifications and data including the following:

a. Compressor Module

Manufacturer
Type and model
Rotative speed
Dimensions
Weight including motor
Performance data at variable discharge
Bearing data
Separator details
Filter and silencer details
Accessory details
Piping schematic
Control equipment
Sequence of operation

b. Motors

Manufacturer
Enclosure
Horsepower rating and service factor
Voltage
Insulation class and temperature rise
Full load rotative speed
Efficiency at full, 3/4, and 1/2 load
Power factor at full, 3/4, and 1/2 load
Full load current
Locked rotor current

c. Air Dryer

Manufacturer
Model
Pressure drop
Electrical wiring diagram and power requirements

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d. Oil Filters

Manufacturer
Model
Pressure drop

C. Operating and Maintenance Data

1. Copies of an operating and maintenance manual shall be furnished to the Engineer as provided for in Section 01730. The manuals shall be prepared specifically for this installation and shall include all required cuts, drawings, equipment lists, descriptions, etc, which are required to instruct operating and maintenance personnel unfamiliar with such equipment.

1.04 REFERENCE STANDARDS

A. American Society for Testing and Materials (ASTM)

1. ASTM A276 – Standard Specification for Stainless Steel Bars and Shapes.

1.05 QUALITY ASSURANCE

A. Qualifications

1. The large bubble compressed air mixing system shall be furnished by a single manufacturer who is fully experienced, reputable and qualified in the manufacture of the equipment to be furnished. The equipment shall be designed, constructed, and installed in accordance with the best practices and methods and shall be as manufactured by PHI Systems Inc., of Oroville Washington. or approved equal.

2. A minimum of 5 years of experience designing and constructing the specified air mixing system and a reference list with at least 5 operating mixing systems for municipal wastewater must be provided.

3. The associated compressed air system shall be supplied as part of this system and shall be manufactured by Ingersoll-Rand, Gardner Denver, or approved equal.

1.06 CONTRACTOR'S RESPONSIBILITY

A. The services of a qualified air mixing system manufacturer's technical representative shall be provided for a total of five (5) days over two (2) site visits as follows:

1. One site visit to check and certify the equipment installation in each basin and perform initial field tests

2. One site visit to supervise initial start-up and operation and to instruct the Owner's personnel in proper operation and maintenance of the equipment.

3. The manufacturer's representative shall sign in and out at the Engineer's Field Office on each day at the project and shall comply with Owner's requirements for visiting the site.

4. A written report covering the representative's findings and installation approval shall be mailed directly to the Engineer covering all inspections and outlining in detail any deficiencies noted.

B. Any additional time required by the manufacturer to achieve successful installation and operation due to the Contractor or scheduling shall be at the expense of the Contractor.

1.07 SYSTEM DESCRIPTION

A. The equipment specified herein shall be a large bubble compressed air mixing system designed to activated sludge by the discharge of high pressure air through nozzles mounted off the floor of anoxic basins. The resulting bubbles shall cause sufficient turbulence in each as in to keep the sludge well mixed to the minimum requirements described in testing procedures described herein. High pressure air will be supplied by the mixing system manufacturer and installed as shown in the Drawings.

B. Each anoxic basin shall be capable of storing 11,200 to 22,400 gallons of thickened activated sludge with a solids content of 1.5 to 4.0 percent.

1.08 MAINTENANCE

A. The following spare parts shall be provided:

1. Four (4) Air Control Valves with pressure transducers

2. One (2) pressure regulator be provided to the Owner in the original manufacturer packaging upon successful start-up of the air mixing system.

3. Other standard spare parts, if any, as recommended by the manufacturer and approved by the engineer.

1.09 WARRANTY

A. The air mixing system manufacturer shall guarantee the performance of the air mixing system for a period of three (3) years and shall guarantee the equipment for a period of three (3) year against defects in materials and workmanship and against problems attributable to ordinary wear under normal operation of the equipment.

B. The compressor manufacturer shall guarantee the equipment for a period of one (1) year against defects in materials and workmanship and against problems attributable to ordinary wear under normal operation of the equipment.

PART 2 PRODUCTS

2.01 MATERIALS

A. The anoxic basin pair shall each be provided with one VCP, each including a Allen Bradley PLC based controller (or approved equal), heater, air pressure regulator, and air control valves to provide mixing air, pre-plumbed in a NEMA 4X FRP enclosure. All enclosures shall be UL rated.

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B. The VCPs shall control the mixing parameters for each anoxic basin pair and shall be equipped with a 6-inch monochrome Allen Bradley (or approved equal) graphical user interface (GUI) for data entry and for changing mixing system parameters. The VCPs shall control the frequency and duration of opening for each Air Control Valve associated with the respective mixing system. Each VCP shall be provided with 120 VAC power.

C. Air mixing system equipment and piping shall be sized to thoroughly mix the contents of the anoxic basins. VCPs shall come pre-plumbed with stainless steel pipe and shall have the ability to handle a working pressure maximum of 80 psi. VCPs shall come with a factory installed heater in the enclosure. The heater shall be sized to maintain 40 degrees F in an ambient outside temperature of 20 degrees F. The heater shall be equipped with a thermostat switch so it will turn off at temperatures above 40 degrees F in temperate weather and shall be powered using 120 VAC power. All components shall be rated for NEMA 4.

D. The piping used for the systems shall be Type 316 stainless steel unless otherwise shown on the Drawings. In-basin components shall be delivered from the manufacturer pre-assembled to the extent practicable to minimize field assembly error and installation time. Provide threaded connections only where required. In-basin, field-assembled piping shall be 1" Sch 5S, Type 316 stainless steel ProPress or Pressfit system, comprised of stainless steel ProPress or Pressfit fittings, coupling, and pipe, unless specified otherwise.

1. All equipment and/or piping to be installed inside new and existing basins. Overhead access to each basin will be available during installation.

E. The air mixing system nozzles or bubble forming plates shall be installed at sufficient locations to provide full floor mixing coverage. Nozzles or bubble forming plates shall be attached to the basin floor with Type 316 stainless steel hardware, be constructed of Type 316 stainless steel material, have adequate strength to withstand vertical and horizontal thrust of the mixing air, and be sized, located, and oriented per manufacturer's recommendation to provide efficient operation of the mixing system. Nozzles or bubble forming plates not directly attached to the basin floor shall not be permitted.

F. The valves supplying air to the in-basin components shall come pre-plumbed in the VCP enclosure and shall have a life expectancy of at least equal to the guarantee period of the mixing system.

2.02 AIR COMPRESSOR MODULE

A. The air compressor module shall include an inlet air filter, compressor with a TEFC AC inverter duty rated motor, air/oil separator reservoir, air cooled oil cooler, air cooled aftercooler, cooling fan, separator pressure relief valve, discharge check valve, moisture separator, controls, control panel complete with compressor VFD, base, valves, piping, and unloading system.

B. The compressor module shall be completely factory assembled requiring only field connection of electrical power and air, and condensate drain piping.

C. The 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.

D. The 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. The male rotor shall be connected with a belt to the drive motor in a manner which will ensure permanent alignment.

E. Radial bearings shall be cylindrical roller type. Thrust bearings shall be in accordance with the manufacturer's recommendations. Bearing life shall be in excess of 90,000 hours.

F. 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 5 micron rating.

G. An air/oil separator reservoir shall be provided. 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 5 $mg/m^3$.

H. Each air compressor module shall have automatic controls integral to the unit for modulating speed to deliver appropriate volume to meet demand and maintain system target pressure. On sensing a low demand, below the speed control range, the compressor will stop immediately and restart when required. Operating at part load, and without the need to raise operating pressure, the variable speed control will avoid load cycling and maintain a steady-state of operation. Controls shall provide a variable speed or auto start/stop control selector toggle switch.

I. A spring-loaded minimum pressure check valve shall be located in the final discharge line of the compressor. The valve shall also prevent backflow of air from the system piping.

J. Each baseplate shall be constructed of one-piece folded 316 stainless 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.

K. 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. A check valve shall be furnished in the air discharge line.

L. Each compressor shall be provided with a dry type intake filter supported by the suction pipe and close-coupled to the compressor intake connection. Intake filters shall have an outer cover and replaceable filter element. Particle arrestance shall be not less than 99 percent at 10 micron size.

M. The compressor shall be provided with a moisture separator rated for the compressor capacity and pressure. Each separator shall be provided with an automatic float operated condensate drain trap.

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N. The compressor shall be supplied in a sound attenuated enclosure. The enclosure shall reduce the measured sound to a maximum of 70 decibels while the compressor is operating and the sound level is measured a distance of three feet from the enclosure.

2.03 AIR DRYER

A. The air dryer shall be of the regenerative desiccant type and shall produce a -40 F pressure dew point at the dryer exit when operating continuously at the design conditions.

B. The dryer shall be capable of continuously drying the maximum discharge capacity of the air compressor.

C. The air dryer shall be as manufactured by Ingersoll-Rand, Gardner Denver, or equal.

2.04 AIR RECEIVER

A. The receiver shall be a horizontal tank integrally-mounted to the compressor. The receiver shall be designed and constructed in accordance with the ASME Code for Unfired Pressure Vessels and shall bear the code stamp.

B. The receiver shall be factory-finished painted with one quart touch-up paint provided.

C. The receiver shall be provided with mounting feet and lifting bars running the length of the receiver.

2.05 COMPRESSOR SYSTEM OIL REMOVAL FILTERS

A. A replaceable-cartridge high-efficiency after-filter and activated carbon oil-removal secondary filter shall be provided and installed at the locations indicated on the drawings. The filters shall remove 100 percent of the solids and liquids 0.025 micron or larger in size. The filter and prefilter shall be oversized to fit the piping sizes indicated on the drawings.

B. The oil removal filters shall be as manufacturer by Ingersoll-Rand, or Gardner Denver.

2.06 COMPRESSOR SYSTEM ACCESSORIES

A. The compressed air equipment package shall be furnished with the following accessory equipment.

1. All shutoff valves shall be ball valves. Shutoff valves in stainless steel tubing shall have Type 316 stainless steel bodies and balls and reinforced Teflon seals and seats. Valves in the compressor discharge piping shall be suitable for the maximum compressor discharge air temperature.

2. Pressure gauges shall have a range of 0 to 200 psig.

2.07 COMPRESSOR SYSTEM ELECTRICAL

A. All electrical and control equipment for the air compressor module shall be furnished as required for a complete installation, requiring only field connection of 480 VAC, three phase power supply.

B. The electric motor shall conform to the requirements of the Section (01 60 01) (01170). Motor shall be rated 480 volts, 60 Hz, three phase.

C. Power supply to the dryer will be 120 V, 60 Hz, single phase.

2.08 COMPRESSOR SYSTEM CONTROL PANEL

A. An enclosure-integrated control panel mounted on the compressor module shall include:

1. Full voltage, nonreversing, circuit breaker type combination motor starters sized as required by the manufacturer.

   a. Starters shall include auxiliary contacts as required plus one spare NO and one spare NC contact wired to the terminal strip. One normally open auxiliary contact shall be provided for RUN status.

   b. Magnetic motor circuit protectors shall be 3 phase, 480 volts, molded-case circuit breakers with instantaneous trip elements. The breakers shall be manually operated with quick-make, quick-break, trip-free toggle mechanism.

   c. One thermal overload relay shall be provided in each phase lead. Each starter shall be provided with an external manual reset push button for reset of the thermal overload relays. Overloads shall be bimetallic ambient compensated type, matched to motor current, and shall be provided with a manual reset pushbutton.

   d. The complete starter shall have an interrupting rating of at least 22,000 amperes at 480 volts.

2. Control power transformers shall have both primary leads fused, one secondary lead fused, and one secondary lead grounded.

3. Terminal blocks for all system wiring. Internal panel wiring shall be neatly bundled and tied and shall be identified with suitable wire markers.

4. A service and maintenance indicator, start button, and power on (green) push button.

5. An emergency stop pushbutton.

6. A protection control system with fault indicator to stop the compressor on high discharge air temperature.

7. The control module shall indicate discharge air pressure, hour meter, time clock, service due warning, service overdue.

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8. LED indicator clearly identified to indicate the following alarm conditions.

9. Two normally open contacts which close under alarm conditions shall be provided for the compressor for remote "FAIL" alarm. Both contacts shall close when any alarm occurs for the compressor. Contacts shall be rated 10 amperes at 120 volts, 60 Hz, single phase.

## 2.09 COMPRESSOR SYSTEM SHOP PAINTING

A. All components of the compressed air equipment system shall be shop primed and finish painted with the manufacturer's premium paint system prior to shipment to the site.

B. Stainless steel, nonferrous, and nonmetallic surfaces shall not be painted.

C. One quart of finish paint shall be provided with the equipment package for field touch-up painting.

## 2.10 COMPRESSOR SYSTEM SHOP TEST

A. Prior to shipment each compressor module and dryer shall be operated to check alignment; faulty equipment and controls; proper wiring; leaks in piping, seals, or wells; and proper operation of the safety and operating controls. Compressor pressure controls shall be adjusted to the specified pressures. Defective equipment and controls disclosed by such tests shall be replaced and the package placed in satisfactory operating condition before shipping. A statement from the package supplier certifying that the specified shop test has been performed shall be submitted to the Engineer prior to shipment. A test report showing capacity, differential pressure, power requirements, and other data shall be submitted for Engineer approval prior to shipment.

## 2.11 COMPRESSOR SYSTEM PERFORMANCE AND DESIGN REQUIREMENTS

A. The compressed air equipment shall be designed for the following operating conditions:

| | |
|---|---|
| **Ambient Conditions** | |
| Max Air temperature, F | 104 |
| Min Air temperature, F | 36 |
| Relative humidity, percent | 36 |
| Barometric pressure, psia | 14.3 |
| **Compressors** | |
| Number required | 2 |
| Minimum discharge pressure, psig | 85 |
| Maximum discharge pressure, psig | 110 |
| Capacity of compressor when operating at 40 psi, cfm | 17-42 |
| Motor size, hp (max) | 20 |
| Max motor speed, rpm | 4670 |

| | |
|---|---|
| Max free field noise level measured at 3 feet, dBA | 80 |
| Receivers | |
| Number required | 1 |
| Design pressure, psig | 225 |
| Nominal volume, gal | 120 |
| Air Dryer | |
| Type | Cycling, Refrigerated |
| Number required | 2, (Integral to Compressor Package) |
| Max Pressure Dew Point (°C) | 7 |
| Filters | |
| Type | Particulate, High Efficiency Oil Removal |
| Number required | 4, (Integral to Compressor Package) |
| Primary Filter Detail (at 21°C) | Particulate- 1 micron |
| | Liquid- 0.6 $mg/m^3$ |
| Final Filter Detail (at 21°C) | Particulate- 0.01 micron |
| | Liquid- 0.01 $mg/m^3$ |

## 2.12 AIR MIXING SYSTEM CONTROL AND OPERATION

A. All control features will be adjustable using the VCP GUI provided by the mixing system manufacturer. Discrete outputs from the VCP PLC shall actuate the Air Control Valves furnished by the air mixing system manufacturer. The VCP PLC based controller will allow monitoring of mixing parameters such as frequency and duration of the opening and closing of the Air Control Valves, and the operator will be able to adjust the parameters using the VCP GUI at any time during the operation of the system. The air pressure shall also be set at the VCP GUI and shall be automatically adjustable.

B. An output shall be provided from each VCP to the existing Plant SCADA system indicating that the air mixing system has a fault.

C. Specific fault location shall be identifiable through observation of the displays on the respective VCP, and the nature of the failure shall be visually identifiable through observation of the Air Control Valves within the VCP.

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PART 3 EXECUTION

3.01 INSTALLATION

A. The Contractor shall furnish and install the air mixing systems and all associated equipment and accessories as required and specified herein in accordance with manufacturer's instructions.

B. The Contractor shall install all of the in-basin components using the details shown on the Drawings; nozzle headers and components attaching to the basin floor shall be completely level.

C. All panels and enclosures shall be mounted as shown on the Drawings using Type 316 stainless steel hardware using the mounting holes or brackets supplied by the manufacturer of the mixing system.

D. The panels shall be pre-wired and the Contractor shall provide power and control connections to each of these panels as required by the manufacturer and the contract documents.

3.02 TESTING AND START-UP

A. The Contractor shall demonstrate to the Engineer that the completed systems meet the functional requirements intended and that all components of the system are properly calibrated.

B. All preassembled piping shall pass factory shop testing to 110 psi. All leaks shall be corrected and piping retested prior to delivery. Testing certification shall accompany preassembled piping delivery and submitted to Engineer for review.

C. All field assembled air piping shall be tested by Contractor for leaks using soapy water on all joints and applying 75 psi test pressure to all piping. All field assembled air piping in the tanks shall be tested by submersing the piping using non-potable water and pressurizing the piping to 75 psi. Preassembled piping (see 3.02.B above) and its specific connection to nozzles and tank air piping are excluded from this requirement.

3.03 EQUIPMENT IDENTIFICATION

A. Each component of the air mixing system shall be provided with a durable nameplate, securely fastened in a conspicuous place and clearly inscribed with the manufacturer's name, year of manufacture, serial number, and principal rating data.

3.04 FIELD ACCEPTANCE TEST

A. After installation and the specified start-up procedures, each basin shall be tested as follows:

1. The Contractor shall pay all costs for an independent laboratory to conduct total suspended solids (TSS) analysis for all samples. The analysis shall be performed in accordance with "Standard Methods for the Examination of Water and Wastewater".

2. Prior to performing the tests, the basins which will be tested must have been in normal operating mode for at least two days with TSS in typical operating ranges as defined above.

3. All mixer systems shall be tested with the respective basins full to the maximum water surface elevation with activated sludge and with no flow entering or exiting the respective basin for two hours prior to and during the test.

4. All personnel and equipment necessary to conduct and supervise all testing shall be provided by the mixer manufacturer.

5. Testing Procedure:

   a. Three sample sites for each mixed zone to be tested shall be selected by the Engineer. At each sample site, three samples shall be collected as follows: 24-inches from the surface, mid-depth and 24-inches off the basin bottom. Each sample site must be a minimum of 18 inches away from any structure within the tank. The nine samples for each location shall be analyzed as described above.

   b. The Coefficient of Variation (Cv) shall be calculated for each set of nine (9) samples collected per zone as follows:

      Cv = (100 x Standard Deviation of All Nine Samples)/(Mean Value of Nine Samples)

   c. If the Cv is less than or equal to 10%, then the mixer performance shall be acceptable for that location.

   d. If the Cv is greater than 10%, 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 10% for that location.

END OF SECTION

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# SECTION 11375

# DISC-TYPE FINE BUBBLE DIFFUSERS

## PART 1 GENERAL

### 1.01 SCOPE OF WORK

A. Furnish all labor, materials, equipment, and incidentals required and deliver complete and ready for installation the fine bubble Perforated Membrane diffuser aeration system as shown on the Drawings and as specified herein.

B. The work includes the following aeration systems which are described herein and shown on the Drawings: Aeration Basins 1 – 3. The systems include, but are not necessarily limited to diffusers, piping, fittings, supports, drains and anchorages. The limit of work is the connection to the stainless steel dropleg two feet below the top of wall elevation and as noted on the Drawings.

C. This Section is intended to give a general description of what is required, but does not cover all details which will vary in accordance with the requirements of the equipment furnished. It is intended to cover the furnishing and testing of everything required for a complete, efficient diffused aeration system. All necessary accessory equipment and auxiliaries shall be furnished, whether specifically mentioned in this Section or not, as required for a proper installation of a complete system.

### 1.02 RELATED WORK

A. Concrete work is included in Division 3.

B. Instrumentation and control work, except as specified herein, is included in Division 13. Instrumentation and controls provided in this section shall adhere to Instrumentation and Control Specifications Sections in Division 13.

C. Piping, pipe hangers, supports, valves and appurtenances are included in Division 15. Items provided under this section shall adhere to the requirements of this section and Division 15.

D. Stainless steel droplegs are included in Division 15.

E. Electrical work is included in Division 16.

### 1.03 SUBMITTALS

A. Submit, in accordance with Section 01300, shop drawings and product data showing materials of construction and details of installation for:

1. Diffusers elements, diffuser element holder, retainer, gasket and orifice.

2. Piping, fixed joints, guide joints, expansion joints, piping supports, pipe taps.

3. Anchoring system for manifolds and distribution laterals for the aeration system.

4. The weights of the equipment including the weight of the largest item or component.

B. Complete bill of materials for all equipment.

C. Design Data

1. Complete headloss calculations for the equipment from the top of the dropleg.

2. Complete oxygen transfer calculations based on guaranteed performance.

D. Test Reports

1. Complete test procedure description and certified copies of the results of all tests specified herein.

E. Manufacturers Installation Instructions

1. Certified erection drawings showing material details of construction, dimensions, anchor bolt locations, and all other details required for a proper installation. Description of the Contractor's proposed method for ensuring a level installation of all equipment and methods of tightening bolts, diffuser hold-down rings, etc.

F. Operation and Maintenance Data

1. Submit operation and maintenance instructions in accordance with Section 01730. The instructions shall be prepared specifically for this installation and shall include all required cuts, drawings, equipment lists, descriptions and necessary information required to instruct operating and maintenance personnel with the equipment. The maintenance instructions shall include trouble shooting data and full preventive maintenance schedules.

G. Descriptive literature, bulletins and/or catalogs of all equipment.

H. A list of the manufacturer's recommended spare parts.

I. Complete calculations and drawings demonstrating that the entire system, including the manifolds, laterals, drain lines and moisture purge system meet requirements for expansion and contraction as specified in Paragraph 1.06D below.

1. Drawings and calculations shall show how the system will expand/contract under the range of conditions specified and demonstrate that manifold headers, lateral pipes, pipe fittings, expansion joints, piping supports, etc, for the entire system supplied comply with requirements specified in Paragraph 1.06D below. If deflection of piping at joints is allowed, calculate the maximum amount of deflection that will occur and compare the deflection to the maximum allowable for the type of joint used and confirm that the joints will not leak and that the expansion and contraction are acceptable for the specified condition.

1.04 REFERENCE STANDARDS

A. American Society for Testing and Materials (ASTM)

1. ASTM A240 – Standard Specification for Heat-Resisting Chromium and Chromium-Nickel Stainless Steel Plate, Sheet and Strip for Pressure Vessels (2006)

2. ASTM D1784 – Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds (2006)

3. ASTM D1785 – Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40,80, and 120 (2006).

4. ASTM D3034 – Standard Specification for Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings (2006)

5. ASTM D2466 – Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40 (1996)

6. ASTM D2855 - Standard Practice for Making Solvent-Cemented Joints with PolyVinyl Chloride) (PVC) Pipe and Fittings (1996)

B. American Iron and Steel Institute (AISI)

C. American Society of Civil Engineers (ASCE)

1. ASCE/EWRI 2-06 - Measurement of Oxygen Transfer in Clean Water.

D. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.05 QUALITY ASSURANCE

A. The diffuser system shall be furnished by a single manufacturer regularly engaged in the manufacture of diffused aeration systems for wastewater treatment. The equipment shall be manufactured and installed in accordance with the best practices and methods.

B. The diffuser system shall be as manufactured by Stamford Scientific International (SSI), xylem-Sanitaire, Siemens Water Technologies (Envirex product line), or EDI (Environmental Dynamics, Inc). The system shown on the Drawings is that manufactured by SSI. Equipment from any of the other named manufacturers is acceptable provided that the equipment meets all requirements specified herein. If the equipment accepted requires an arrangement or space differing from that indicated on the Drawings or specified, the Contractor shall prepare and submit to the Engineer for approval detailed drawings and equipment lists showing all necessary changes and embodying all special features of the equipment to be furnished. Such changes, if approved, shall be at no additional cost to the Owner. The Contractor shall assume the cost of, and responsibility for, satisfactorily accomplishing all the necessary changes for installation of the alternate equipment as approved by the Engineer.

B. Services of Manufacturer's Representative

1. Provide services of a manufacturer's service representative, specifically trained on the type of equipment installed as specified herein. Submit qualifications of service representative for approval. Instruction requirements listed below are exclusive of travel time, and do not relieve Contractor of obligation to provide sufficient service to place equipment in satisfactory operation.

   a. Installation instruction: as specified in paragraph 3.04 below.

   b. Operation and maintenance instructions: two eight-hour days.

C. Warranty

1. The Contractor shall provide from the equipment manufacturer an extended warranty for a period of 24 months after acceptance of the equipment by the Owner. The warranty shall stipulate that the equipment furnished is suitable for the purpose specified and free from defects of material and workmanship for the duration of the extended warranty. In the event the equipment fails to perform as specified within the warranty period, the Contractor shall promptly repair or replace the defective equipment at no cost to the Owner.

## 1.06 DESCRIPTION OF SYSTEM

A. All of the equipment specified herein is intended to be standard aeration equipment capable of transferring atmospheric oxygen into the activated sludge mixed liquor and to create adequate mixing to keep the mixed liquor solids in suspension. The aeration system consists of fine bubble membrane diffusers, aeration piping including droplegs, manifolds and distribution headers, supports and appurtenances.

B. System Responsibility

1. All equipment specified under this Section shall be furnished by the manufacturer of the diffuser who shall have sole responsibility for designing and furnishing all the parts and components required for a complete and operable system; however, all equipment need not be manufactured by a single manufacturer.

C. Performance Requirements

1. The aeration basins are used to reduce the biochemical oxygen demand (BOD) and to provide for full nitrification. The diffused aeration system is to provide full floor aeration as shown on the Drawings. Diffusers shall operate within the manufacturer's design range at full capacity and at lower air flow ranges required to meet mixing limited conditions per ASCE/WEF. Minimum air flow in all grids at average air flow rate shall not be less than 0.12 scfm/sq ft of aeration tank surface area.

2. Design Criteria

   a. Design flow (w/o RAS or IR flow) (mgd) — 7.3 (avg), 21.0 (max)

   b. Minimum temperature range of mixed liquor — 23 degrees (C)

c. Basin volumes

| | | |
|---|---|---|
| 1) Basin No. 1 (MG) | .43 | |
| 2) Basin No. 2 (MG) | .43 | |
| 3) Basin No. 3 (MG) | .64 | |
| 4) Total Volume (MG) | 1.5 | |
| d. Basin liquid depth (ft) | 15 (avg) | 17 (max) |
| e. Diffuser submergence (ft) | 14.25 (avg) | 16.25 (max) |
| f. Minimum Dissolved Oxygen (DO) Concentration (mg/l) | 2 | |
| g. Standard Oxygen Required (SOR) (lb/d) | 11,358 (avg), 17,037 (max) | |
| h. Total Standard Cubic Feet per Minute (scfm) | 3,208 (avg), 4,813 (max) | |
| i. Minimum Clean Water Oxygen Transfer Efficiency (OTE) (percent) | 2 avg and max | |
| j. Alpha correction factor | 0.70 | |
| k. Beta correction factor | 0.95 | |

l. Maximum diffusion system headloss from drop pipe through diffusers at standard conditions stated in 1.06C.3 at the maximum operating depth with the required diffusers and blanks in place (exclusive of static head)

| | |
|---|---|
| 1) Aeration Basin No. 1 (psi) | 0.6 |
| 2) Flocculation Basin No. 1 (psi) | 0.6 |
| 3) Aeration Basin No. 2 (psi) | 0.6 |
| 4) Flocculation Basin No. 2 (psi) | 0.6 |
| 5) Aeration Basin No. 3 (psi) | 0.6 |

m. Minimum quantity of 9-inch diffusers

| | |
|---|---|
| 1) Aeration Basin No. 1 | 567 |
| 2) Flocculation Basin No. 1 | 284 |
| 3) Aeration Basin No. 2 | 567 |
| 4) Flocculation Basin No. 2 | 284 |
| 5) Aeration Basin No. 3 (Zone 1) | 613 |
| 6) Aeration Basin No. 3 (Zone 2) | 410 |
| 7) Aeration Basin No. 3 (Zone 3) | 191 |

3. Clean water oxygen transfer efficiencies shall be measured at Standard Conditions, at the specified average diffuser submergence, and by test procedures and conditions as specified in Paragraph 3.01 below. Standard Conditions are defined as 14.7 psia, 68 degrees F, and 36 percent relative humidity.

4. Manifolds and laterals shall be designed to carry at least 200 percent of the specified airflow rates.

5. The Contractor may increase the number of diffusers provided over the minimum presented above in order to comply with requirements specified Paragraph 1.06C.2 herein regarding clean water oxygen transfer and mixing requirements. If the number of diffusers provided in any zone is increased over the number specified, then the number of blanks provided in that zone shall also be increased to maintain the specified blank to diffuser ratio in Paragraph 1.06C.6 below.

6. The aeration basins shall be provided with a minimum of 10 percent blank diffuser saddle/base plates per grid. The minimum blanks shall be determined based on the number of diffusers required to satisfy the specified standard oxygen transfer efficiency (SOTE) percent in addition to the active diffusers specified above. Blanks shall be uniformly distributed throughout each grid. Mounting saddles as well as the diffuser base/holder and retaining ring of the type to be installed by the Contractor shall be installed at each blank site, and plugged by the Contractor so that the future installation of diffusers requires only placement of the diffuser membrane and removal of the plug. All blanks and diffusers must be in place prior to performing field tests specified in Paragraph 3.05 below.

7. Diffusers shall be arranged in such a manner that each diffuser shall be easily accessible for manual removal and replacement and for in-place cleaning of the diffusers. The rows shall also provide a clear walking space of a minimum of 18-in between the laterals. Maximum spacing between diffusers on lateral pipes and laterals shall be based on manufacturer's recommendations to meet the requirements of this Section and to prevent deposition of solids, but under no circumstances shall the spacing between diffusers exceed 4-ft center to center of diffusers or 2-feet from center of diffuser to any tank wall unless otherwise noted on the Drawings.

D. The range of mixed liquor suspended solids (MLSS) will be 3,000 to 5,500 mg/l. The installed system shall adequately suspend the MLSS in aeration grid at a minimum air flow rate of 0.6 scfm per diffuser.

E. The entire system, including the manifold, laterals, drain lines and moisture purge system shall allow for expansion and contraction under the following conditions:

1. Winter conditions, empty aeration tanks (20 degrees F).

2. Summer conditions, empty aeration tanks (100 degrees F).

3. Operation with air supply as 225 degrees F and aeration tanks full.

4. Operation with air supply at 225 degrees F and water level in aeration tanks 2-ft above diffusers.

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1.07 DELIVERY, STORAGE AND HANDLING

A. Ship equipment, material and spare parts complete except where partial disassembly is required by transportation regulations or for protection of components. No shipment shall be made until approved by the Engineer in writing.

1. At the time of shipment, the shipping list, original bill of loading, shipping memorandum and invoice shall be delivered in triplicate to the Engineer. Each shipping list shall give the description and net weight of each item, and gross weight of the shipment. Shipment will not be accepted until the list has been received. Demurrage or other charges resulting from failure to furnish these lists shall be absorbed by the Contractor.

B. Pack spare parts in containers bearing labels clearly designating contents and pieces of equipment for which intended. Each box or package shall be legibly marked to show its net weight.

C. All components shall be properly protected so that no damage or deterioration will occur during a prolonged delay between time of shipment and installation, including any prolonged period at the site.

1. All diffuser components shall be wrapped at the factory for protection from sunlight, snow, rain, drippings of any sort, dust, dirt, mud, flood and condensed water vapor. The protective coverings shall remain in place until the work areas are ready for installation. Full details of proposed protective measures shall be submitted for approval to the Engineer prior to shipment.

2. Finished surfaces of all exposed parts shall be properly protected against adverse conditions that may prevail from the time of shipment until ready for operation.

D. The finished surfaces of all exposed flanges shall be protected by wooden blank flanges or plastic inserts, strongly built and securely bolted thereto.

E. Lateral piping and diffuser holders shall be arranged and clearly marked for the tank and grid for which they are intended.

1.08 SPARE TOOLS AND SPARE PARTS

A. Provide one set of special tools that are required for normal operation and maintenance. Tools shall be packaged in a steel case, clearly and indelibly marked on the exterior to indicate equipment for which tools are intended.

B. Provide the following spare parts:

1. A number of spare diffusers equal to at least 10 percent of the total number of installed diffusers. This shall include diffusers, gaskets, replaceable air flow control orifices and all required bolts, hold-down rings, and nuts.

2. Sufficient material to repair 10 percent of all expansion joints supplied under this Contract.

3. Sufficient material to replace 4 percent of pipe supports, including nuts and bolts. Two twenty-foot sections of complete lateral distribution pipes for each spacing of diffusers supplied, including diffuser holders.

4. One complete air purge system.

C. All spare parts shall be packed in containers which are clearly and indelibly identified as to their contents. All items shall be suitably packed and protected for long periods of storage.

## PART 2 PRODUCTS

### 2.01 GENERAL

A. All equipment shall be supplied complete. Parts shall be proportioned to have liberal strength, stability and stiffness and shall be especially adapted for the intended service. Ample room and facilities shall be provided for inspection, repairs and adjustments.

B. All equipment furnished herein is intended to be submerged in wastewater. No part shall be of any material other than EPDM, fiberglass filled polypropylene, plastic, UPVC, Type 304L or 316Lstainless steel, or gasket material.

C. All equipment that will come in contact with the compressed air shall be suitable for operation with compressed air at temperatures resulting from the service conditions described in Paragraph 1.06E above when said equipment is submerged in water or wastewater.

D. UPVC parts shall be suitable for long term exposure to compressed air at temperatures up to 225 degrees F when submerged in water or wastewater.

E. The diffuser layouts presented on the Drawings and airflow rates per diffuser specified are based on 9-inch diameter diffusers.

### 2.02 STAINLESS STEEL MATERIALS AND FABRICATION

A. All welded parts and assemblies shall be fabricated from sheets and plates of Type 304L stainless steel with a 2D finish conforming to AISI 304L and ASTM A240.

B. All non-welded parts and pieces shall be fabricated from sheets and plates of Type 304 stainless steel conforming to ANSI 304 and ASTM A240.

C. All nuts, bolts and washers, including anchor bolts shall be furnished in Type 316 series stainless steel.

### 2.03 PVC MATERIALS AND FABRICATION

A. All PVC moldings and extrusions shall be produced from PVC compound conforming to ASTM D1784, compound cell classification 12454-B with a minimum tensile strength of 7,000 psi. PVC parts shall be suitable for long term exposure to compressed air at temperatures up to 200 degrees F.

B. The manufacturer shall blend PVC resins and limit amount of fillers to achieve a minimum "K" value of 58 for fittings and a minimum "K" value of 64 for pipes.

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C. Distribution headers shall be provided as shown on the Drawings conforming to ASTM D1785 or ASTM D3034 and a hydrostatic design stress rating of 2,000 psi.

D. PVC fittings shall be provided as shown on the Drawings and conforming to ASTM D2466.

E. Solvent Welding

1. Solvent welded PVC joints shall be welded in the factory in accordance with ASTM D2855 except edges need not be chamfered. All solvent welding shall be with solvent cements specifically formulated for use with PVC in accordance with ASTM D2564. Field solvent welding will not be permitted.

2. Solvent welding shall be with solvent cements specifically formulated for use with PVC.

2.04 PIPING

A. Furnish connections to stainless steel droplegs and manifolds of minimum sizes shown on the Drawings and 4-in diameter lateral distribution piping.

B. PVC piping and parts shall be manufactured of unplasticized polyvinyl chloride (UPVC) with a minimum of 2 percent $TiO_2$ added for ultraviolet protection.

C. All UPVC piping shall be suitable for use in wastewater. Dropleg connections and air manifolds shall be Schedule 40 UPVC. Lateral pipe shall conform to a minimum SDR26 with a hydrostatic design stress rating of 2000 psi. Lateral pipe lengths shall not exceed 20-ft.

D. Dropleg connections and manifolds shall be supplied with flexible couplings, expansion joints, pipe supports, etc, as shown on the Drawings, or as required by the manufacturer for alignment of the system and to meet the expansion/contraction requirements as specified in Paragraph 1.06D above.

E. The air diffuser distribution laterals shall include the piping, diffuser element holders, joints, expansion joints and air purge-drainage system.

F. The distribution laterals shall connect to the side centerline of the manifold by flange connections or by fixed joint union-type connections. Type 316 stainless steel nuts and bolts, gaskets, backing flange and other accessories shall be provided for each flanged connection. Fixed joint couplings shall provide an air tight connection between the distribution lateral and the manifold and shall also provide a positive locking joint and an anti-rotation feature. Joints that rely on friction alone as the anti-rotational feature shall not be acceptable. The system shall meet the expansion/contraction requirements as specified in Paragraph 1.06D above.

G. Fixed joints shall be factory solvent welded to the distribution laterals. Solvent welds must be factory assembled and tested prior to shipment. No field solvent welding will be permitted.

H. All pipe support systems shall have a factor of safety of 4 or greater against calculated buoyant forces when installed. All anchor bolts shall have a factor of safety of 10 or greater against calculated buoyant forces when installed.

I. The diffusers shall be level to plus or minus 1/4-in. All diffuser piping and diffusers shall be capable of being leveled to this tolerance and remaining level under all conditions of operation whether the aeration tanks are full, partially full, or empty.

J. Lateral piping shall include an expansion-contraction system consisting of fixed joints and guide supports. Guide supports shall allow longitudinal movement for expansion-contraction of the lateral piping. Supports shall:

1. Provide proper bracing and means for accurate field alignment and adjustment of diffuser piping vertically and longitudinally. Each pipe section shall have at least two supports and support spacing shall not exceed 7-ft-6-in. Sections of lateral piping shall be joined with fixed joints which prevent joint blow-apart and rotation of one pipe section with respect to another.

2. Provide for any expansion or contraction of the diffuser piping resulting from temperature change by using guide supports. Expansion joints shall not be used for joining pipe sections. Allow for expansion and contraction over a range as specified in Paragraph 1.06E.

K. Expansion couplings shall operate at an average force of 50 lbs.

L. All piping gaskets shall be butyl rubber, neoprene, or a composition suitable for air to 230 degrees F. Gasket material shall be suitable for long term immersion in wastewater.

M. Provide one drainline, sump and air lift purge systems for each grid:

1. Furnish one in-line manifold purge sump and air lift purge system to drain the entire submerged aeration piping system for each aeration grid.

2. The sump shall be integral with the manifold and its bottom elevation shall be lower than the invert of the air distribution laterals and manifold.

3. Connect drain sump to 3/4-in diameter airlift line extending from the sump invert elevation. Extend this airlift line to a point above the tank water level and terminate with a horizontally mounted PVC ball valve accessible from finished grade. Air lift line shall utilize a flexible connection between the drain sump and the vertical pipe run at the aeration tank wall.

N. The following PVC pipelines and taps shall be provided (one set per grid) for a connection to a Pressure Monitoring System.

1. One lateral and diffuser per grid, located adjacent to an operator accessible wall, shall be provided with ½-in PVC fittings and reinforcing saddles, with the fittings and saddles solvent welded to the lateral and diffuser holding assembly. The fittings to the diffuser holding assembly shall be between the flow control orifice and the diffuser element. The fittings shall be capped and suitable for connection to a pressure monitoring system.

2. The caps shall be suitable for permanent operation of the aeration system without installation of the pressure monitoring system.

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2.05 MEMBRANE DISC DIFFUSER AND ASSEMBLIES

A. Furnish diffuser assemblies consisting of a diffuser membrane with integral gasket, diffuser holders, air flow control orifice and retaining device.

B. Furnish PVC or fiber reinforced polypropylene diffuser element holders with an air plenum chamber below the diffuser support plate.

1. Element holders shall provide complete peripheral edge support for the membrane diffuser element.

2. Attach element holders to the distribution laterals to resist the following torque values.

a. About polar axis of holder: 150 ft-lbs.

b. About longitudinal axis of holder: 100 ft-lbs.

3. Furnish a retaining device to securely hold and seal the membrane diffuser to the holder.

a. Diffuser elements shall be secured to the diffuser holder assemblies in a manner that shall not allow passage of air at diffuser - holder interface.

b. Provide a method to vary the applied sealing force between the holder and membrane diffuser. Sealing method or retaining device shall generate a minimum of 50 lbs/in of circumference of the holder to provide a long-term positive seal and prevent air escape through the active area of the diffuser membrane.

4. Screw on retainer rings shall be provided with a positive O-ring seat and a minimum of 2-1/2 complete threads for engagement. Threads shall have a minimum cross section of 1/8-in.

5. Each diffuser assembly shall incorporate a flow control orifice of a size that will ensure that air distribution throughout each grid will be evenly distributed at the ranges of air flow specified in Paragraph 1.06C above.

a. The air release of the orifice shall be such that air entering the diffuser assembly shall be distributed evenly under the horizontal surface of the diffuser element when submerged in water. Orifice size shall also result in system head losses that meet the requirements specified in Paragraph 1.06C above.

b. Provide orifice plugs for diffuser assembly blank spaces as shown on the Drawings. The orifice plug shall be airtight under all operating conditions.

C. Number of Diffuser Assemblies

1. Furnish the number of disc shaped diffuser assemblies required to supply the total air flows and oxygen transfer specified without exceeding the head losses specified. The minimum number of diffusers to be provided is specified in Paragraph 1.06C above.

D. Membrane Materials and Fabrication

1. Diffusers shall be membrane diffuser discs of EPDM with precision die-formed perforation with a minimum diameter of 9-in. The diffusers shall be guaranteed for the oxygen transfer specified in Paragraph 1.06C above.

2. Membrane discs shall include an integral sealing gasket.

3. Furnish PVC or fiber reinforced polypropylene diffuser support base.

4. Diffuser membranes shall provide a uniform distribution of air bubble release across the active surface of the diffuser element when submerged in water.

5. Diffuser membranes shall comply with the following criteria:

   a. Membrane shall collapse and seal when aeration system air is turned off.

   b. Membrane material shall meet the following:

| Item | Value/Units | ASTM |
|---|---|---|
| Base Polymer | EPDM | D573 |
| UV Resistance | Carbon Black | |
| Specific Gravity | 1.25 or less | |
| Durometer – Minimum | 58% ± 5% | D2240 |
| Modulus of Elasticity | 500 psi | D412 |
| Ozone Resistance (72 hrs: 40 degrees C pphm) | No cracks @ 2X magnification | D1171 Test A |
| Tensile Strength | 1200 psi | D412 |
| Elongation - %<br>- Retained 70 hrs @ 100 degrees C<br>- Minimum at break | <br>75% Max<br><br>350% | <br>D573<br><br>D412 |

6. The membrane material shall be capable of providing a 7 year life in the plant wastewater environment.

2.06 SUPPORTS

A. Manifold Supports

1. Provide Type 316L stainless steel manifold supports spaced as specified above. Supports shall be anchored to the tank floor with Type 316, 3/8 inch diameter wedge anchors.

2. Manifold supports shall include manifold hold down and supporting structure.

3. Stands shall be designed to resist the following uplift without exceeding 24,000 psi design stress.

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| Manifold Diameter (Inches) | Uplift Force Per Support Pounds |
|---|---|
| 4 | 195 |
| 6 and 8 | 325 |
| 10 and 12 | 543 |

4. Supports shall be provided with a mechanism to provide for plus or minus 2-in vertical and 1/2-in lateral adjustment for alignment of the manifold in the field.

B. Air Distribution Lateral Supports

1. Provide Type 316L stainless steel air distribution lateral supports spaced as specified above. Supports shall be designed in accordance with Paragraph 2.06A3 above.

2. Fixed supports shall consist of a hold-down mechanism and self-limiting clamp device.

   a. The stainless steel hold-down mechanism and clamp shall provide a wide contoured bearing surface for the air distribution lateral. PVC or FRP supports will not be allowed.

   b. The clamping device shall be self-limiting to prevent over-stressing the lateral if the clamp is over-tightened.

3. Intermediate guide supports shall consist of a self-limiting hold-down and sliding mechanism.

   a. The hold-down and sliding mechanism shall provide a contoured bearing surface with chamfered leading edges to minimize binding of the air distribution lateral.

   b. The sliding mechanism shall provide minimum resistance to movement of the air distribution lateral under full buoyant uplift load. The mechanism shall provide 1/8-in clearance around the lateral and be self-limiting if the mechanism is over-tightened.

   c. A maximum horizontal thrust of 20 lbs or less shall be sufficient to initiate movement of the lateral relative to the mechanism under full buoyant uplift load.

4. Supports shall be provided with a mechanism to provide for plus or minus 2-in vertical adjustment for alignment of the air distribution lateral in the field. The adjusting and aligning mechanism shall be infinitely adjustable within its limits to allow precise leveling of the air distribution lateral and diffuser assemblies to within plus or minus 1/8-in of a common horizontal plane without removing the lateral from the support.

5. Support shall be anchored to the tank floor with Type 316L stainless steel 3/8 inch diameter wedge anchor bolts . Each anchorage shall be designed to withstand at least 450 lbs of withdrawal force. Anchorage bolts and support rods for fixed supports shall be a minimum 1/2 inch diameter and anchorage bolts and support rods for guide supports shall be a minimum 5/16" diameter.

2.07 EXPANSION JOINTS

A. Expansion joints shall be provided as required to prevent thermally induced stresses due to expansion and contraction over the temperature range specified in Paragraph 1.06D above. Expansion joints shall be air tight and permit free and easy movement of the plain end of the lateral within the coupling barrel.

B. Expansion joints shall be of UPVC consisting of a plain end, EPDM O-ring, threaded union type connection and expansion barrel to accommodate movement over the temperature ranges specified in Paragraph 1.06D above. Provide positive means to prevent joint blow-apart.

2.08 PRESSURE MONITORING SYSTEM

A. Provide monitoring equipment to measure the dynamic wet pressure (DWP) and operating air flow rate of a diffuser in each aeration zone.

B. Provide two portable monitoring panels in a NEMA 4X fiberglass enclosure with Type 316 stainless steel handrail bracket. Provide monitoring panels with differential pressure gauges of Type 316 construction, quick disconnect couplings, air flow meter, air blow-down ball valve, and one set of calibration curves.

C. Provide one NEMA 4X fiberglass connection box with Type 316 stainless steel handrail mounting brackets and carrier column assembly per grid. Connection box shall include connections to measure lateral air pressure, flow control orifice differential pressure, diffuser element operating pressure (DWP), and isolation valves.

D. Provide flexible tubing from connection box to air distribution lateral pipe, diffuser element holder, and bubbler line. Install flexible tubing in a single 1-1/2" Schedule 40 UPVC carrier pipe with Type 316 stainless steel supports at 5'-0" maximum center to center spacing.

PART 3 EXECUTION

3.01 FACTORY OXYGEN TRANSFER TEST

A. General

1. Prior to shipment of any equipment to the site, performance tests shall be conducted on the fine bubble fixed-grid aeration system to demonstrate the clean water transfer efficiency. Tests shall be conducted for lateral spacing, diffuser densities and maximum and average airflow rates for each grid as specified in paragraph 1.06 above.

2. A series of at least three tests shall be conducted, along with such additional tests as may be required to establish the performance and repeatability criteria specified herein.

3. Performance tests shall be conducted by the clean water, nonsteady state sulfite method as described in Paragraph 3.02B2 below. All testing shall be performed in a manner acceptable to the Engineer.

4. The tests shall be supervised by the equipment manufacturer. The Contractor shall be fully responsible for providing all support facilities which shall include, but not be limited to: chemical storage tanks, mixing equipment and chemicals as required for

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dissolved oxygen determinations by the modified Winkler method; chemicals for $K_La$ determination by the nonsteady state sulfite method; DO probes, instruments and recorders; scales and such other equipment, personnel and facilities as may be necessary.

5. Submit with the shop drawings the proposed testing procedures including equipment details sketches and supplies.

6. Provide such personnel as are required to aid the equipment manufacturer to set up and conduct the tests. The authorized representative of the diffuser manufacturer shall be present for all tests, such representative being familiar with the operation of all the equipment furnished. Qualified personnel shall perform the tests and record the data. The required calculations and the preparation of a report on the results shall be done by the equipment manufacturer and approved by Engineer. The information collected shall be used as a basis for determining acceptability of the equipment. In case of any conflict, interpretations and calculations made by the Engineer shall govern.

7. Air Measurement

   a. Measure air flow during testing with two types of devices, each with the test flow at mid-range of the scale. Flow measurement shall be with a sharp-edge orifice plate, flow tube or similar device. Air flow meter shall be calibrated prior to use. A certified calibration shall be submitted to the Engineer.

      1) Locate the device in a location compatible with accurate measurement.

      2) Utilize a direct reading manometer to measure the system pressure drop to within one half of an inch of water column.

      3) Measure in-line pressure and temperature upstream of the flow measurement device with a manometer and temperature sensor accurate to within plus or minus 5 degrees F.

      4) Measure atmospheric temperature, pressure and relative humidity on site during testing.

      5) Report the air rate in standard cubic feet per minute (SCFM), using calibration curves and correction factors for the device.

      6) Measure the air flow rate at least two times during each test. The air rate shall be within 0.05 scfm per diffuser element of that to be tested. Any single observation shall be within 2.5 percent of the mean for that test run.

8. Water and power for operation of the air blowers shall be provided by the equipment manufacturer.

9. Data to be collected shall include, but not be limited to:

   a. Air flow rate.

   b. Rate of change of dissolved oxygen concentration.

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c. Liquid and air temperatures.

d. Barometric pressure readings.

e. Diffuse submergence.

f. Additional data as necessary to determine compliance with this Section.

10. Furnish test equipment which includes, but is not limited to:

a. Five - DO probes with integral stirrers.

b. Five - DO meters with strip-chart or discrete value printout recorders, if desired in place of additional personnel.

c. One lot - Thermometers for ambient air, compressed air and liquid temperature measurements.

d. One - Mercury barometer with manufacturer's literature for making corrections for thermal expansion of the indicating scale, change in mercury density with temperature and gravitational field.

e. One - Sling psychrometer with relative humidity tables.

11. Test tank size shall be appropriate to eliminate potential interference resulting from wall effects. Extraneous piping and other materials in the test tank shall be minimized. Diffuser placement, density and submergence shall be identical to those specified for the full scale installation. Airflow rate per diffuser, airflow rate per unit volume and area, power input per unit volume, and flow control orifice sizes shall be identical to those specified for the full scale installation.

B. Test Procedures

1. Water used for performance tests shall be tap water. The water level in the basin shall be maintained at the full scale submergence. Tests shall be performed when the water temperature is between 15 and 25 degrees C and after one deaeration-reaeration sequence has been performed on the test water.

2. Test procedures shall follow strictly the ASCE standard, Measurement of Oxygen Transfer in Clean Water.

3. No more than ten tests shall be made on the same test water. The initial deaeration-reaeration sequence on a batch of test water shall not count as one of the ten allowed tests.

C. Calculations of Standard Oxygen Transfer Rate

1. The calculations to be performed on the data produced during testing shall follow the Non-Linear Regression Method as outlined in the ASCE standard.

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2. The calculated values of $(K_La)T$ and Cs shall be reported for each test point during each test and the resulting curve shall be plotted with the data.

D. Shop Performance Tests

1. Prior to conducting the shop test, notification of such test and a list of test equipment and test procedures shall be forwarded to the Engineer at least 2 weeks before the scheduled test date. Certified calibration data shall be provided for all meters, gauges, and other test instruments.

E. All costs for the factory oxygen transfer testing shall be at the expense of the Contractor. The cost of all retesting, if required, shall be borne by the Contractor.

3.02 INSTALLATION

A. All equipment shall be installed in accordance with the manufacturer's instructions and as shown on the Drawings. Installation sequence shall be in accordance with Section 01810.

B. Clean air mains, blowers, filters and droplegs prior to installing diffuser elements. The diffuser elements shall not be installed until the entire system, including the blowers have been thoroughly flushed with air for a minimum of 24 hours.

C. Protect diffuser elements from freezing at all times.

D. Protect diffuser elements from un-pressurized submergence in wastewater.

3.04 INSPECTION

A. Furnish a factory representative experienced in the erection, operation and maintenance of the equipment. The representative shall be present during the initial installation of the diffusion equipment to ensure that satisfactory procedures are followed and shall provide periodic supervision and inspection consisting of a minimum of four visits during the installation of the system. The equipment manufacturer's representative shall in addition, be present to supervise testing and startup of the aeration system and shall provide any other assistance to the Contractor necessary to guarantee satisfactory performance of the equipment.

B. The services of the factory representative shall be provided in accordance with the requirements of Paragraph 3.04A above for a minimum period of 3 days per tank. If there are difficulties in operation of the equipment due to the manufacturer's fabrication or Contractor's installation, additional service shall be provided at no cost to the Owner.

3.05 FIELD ACCEPTANCE TESTS

A. After the installation of all aeration system equipment in one aeration tank, the equipment shall be subject to field acceptance tests as specified herein.

B. Oxygen Transfer Tests. Prior to acceptance by the Engineer, the Contractor shall conduct performance tests on one of the fine bubble fixed-grid aeration system to demonstrate the clean water oxygen transfer efficiency. The tests shall be performed at high and average air flows by test procedures and requirements as specified in Paragraph 3.01A above.

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1. In the event that the system fails to pass the field acceptance test, additional diffusers shall be added as required to meet the specified transfer values at the Contractor's expense. Additional blank diffuser elements shall also be provided in order to maintain the same ratio of blank spaces as specified. The tanks shall be retested to the satisfaction of the Engineer.

C. Mounting Tests. Support and tie-down provisions of the UPVC piping shall be tested to ensure that they have a factor of safety of 4 against calculated buoyant forces. Anchor bolts for the UPVC piping shall be tested to ensure that they have a factor of safety of 10 against calculated buoyant forces.

1. Upon installation of the supports and prior to installation of piping, supports of each type and anchor bolts shall be tested. Testing shall include no less than 10 percent of the supports of each type, chosen at random to be witness tested by the Engineer. Each support chosen for test shall be attached to a lever which shall be placed on a fulcrum. A static load shall be applied to the opposite end producing a vertical extracting force on the support tie-down equal to 4 times the calculated maximum buoyant force to which the support tie-downs will be subjected in normal operation as detailed above. Anchoor bolts shall be tested to a vertical extraction force of 10 times the calculated maximum buoyant force .The application of the test load shall be such that the entire pipe support, including pipe hold down strap and anchor bolts are tested.

D. Inspection of Piping. The piping shall be inspected for proper joints, supports and tie-downs, end plugs and drain relief valves.

E. Level Test. Each aeration tank shall be flooded with clear water to the top of the ceramic diffusers. The level of the diffusers shall then be checked to see that they are at the same elevation within plus or minus 1/4-in. Should it be necessary to correct the elevation of any diffuser assembly as a result of this check, such action shall be taken prior to proceeding further.

F. Uniformity and Leakage Test. Each aeration tank shall be flooded with protected water to a depth of 1-ft above the diffusers. The air supply will be turned on to air flow rates as approved by the Engineer and air supplied evenly to all headers. The surface of the water will then be visually inspected to see that air flow is uniformly distributed across the tanks and that no air leaks are present within the piping system. If in the opinion of the Engineer, there are areas of consistent low or high air quantity release, or leaks within the piping system, make all necessary adjustments to correct these deficiencies.

G. Cost of Testing. All of the above field tests, including the filling, dewatering, and cleaning of the aeration tanks, shall be conducted at the expense of the Contractor. The costs of all retesting, if required, shall be borne by the Contractor.

END OF SECTION

# *DIVISION 13*

# *SPECIAL CONSTRUCTION*

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# SECTION 13300

# INSTRUMENTATION AND CONTROLS – GENERAL PROVISIONS

## PART 1 GENERAL

### 1.01 SCOPE OF WORK

A. The Contractor shall procure the services of a single System Integrator to furnish all materials, equipment, labor and services, required to achieve a fully integrated and operational system as specified herein and in other Specification Sections listed below.

B. Auxiliary and accessory devices necessary for system operation or performance, such as transducers, relays, signal amplifiers, intrinsic safety barriers, and signal isolators, to interface with existing equipment or equipment provided by others under other Sections of these specifications, shall be included whether they are shown on the Drawings or not.

C. Substitutions on functions or type of equipment specified shall not be acceptable unless specifically noted. In order to confirm compatibility between all equipment, coordinate all interface requirements with mechanical and electrical systems and furnish any signal isolation devices that might be required.

D. Equipment shall be fabricated, assembled, installed and placed in operating condition in full conformity with the project Specifications, Drawings, engineering data, instructions, and recommendations of the equipment manufacturer as approved by the Engineer.

E. To facilitate the Owner's future operation and maintenance, similar products (e.g., differential pressure transmitters, SCADA I/O cards) shall be supplied from the same manufacturer.

F. All equipment and installations shall satisfy applicable Federal, State and local codes.

### 1.02 QUALITY ASSURANCE

A. The System Integrator shall be regularly engaged in the design and the installation of instrumentation systems and their associated subsystems as they are applied to the municipal water and wastewater industry.

### 1.03 NOMENCLATURE AND IDENTIFICATION

A. Field Instrument Tags

1. A permanent stainless steel or other non-corrosive material tag firmly attached and permanently and indelibly marked with the instrument tag number, as indicated in the Drawings, shall be provided on each piece of equipment supplied under this Section. Equipment shall be tagged before shipping to the site.

2. Provide 1/8-in by 3/8-in, Type 316 stainless steel button head machine screws.

3. All supplied field instrument transmitters and field instrument transmitter elements

shall have a stainless steel identification tag attached to each transmitter and element prior to shipment. Tag shall be attached via stainless steel chain or stainless steel wire (24 gauge min) to a non-removable part of the device. The tag size shall be a minimum of 1.5 square inches. Tag shall include the ISA alphanumeric instrument number as indicated in the P&ID, loop, and detail drawings. The alphanumeric instrument number shall be stamped into the tag and shall have a minimum of 3/16-in high alphanumeric characters.

1.04 PROJECT/SITE REQUIREMENTS

A. Temperature:

1. Outdoor areas' equipment shall operate between -30 to 50 C degrees ambient.

2. Equipment located in indoor locations shall operate between 10 to 35 C degrees ambient minimum.

3. Storage temperatures shall range from 0 to 50 C degrees ambient minimum.

4. Additional cooling or heating shall be furnished if required by the equipment as specified herein.

B. Relative Humidity. Air conditioned area equipment shall operate between 20 to 95 percent relative, non-condensing humidity. All other equipment shall operate between 0 to 100 percent relative, condensing humidity.

PART 2 PRODUCTS

2.01 PRODUCTS GENERAL

A. All instrumentation and electronic equipment shall be of the manufacturer's latest design, utilizing printed circuitry and epoxy or equal coating to prevent contamination by dust, moisture and fungus. The field mounted equipment and system components shall be designed for installation in dusty, humid and slightly corrosive service conditions.

B. All instruments shall be provided with mounting hardware and floor stands, wall brackets, or instrument racks unless otherwise noted. Fasteners for securing control panels and enclosures to walls and floors shall be either hot-dipped galvanized after fabrication or stainless steel.

C. All indicators shall be linear in process units, unless otherwise noted. All transmitters shall be provided with indicators in process units, accurate to two percent or better.

D. All equipment, cabinets and devices furnished shall be heavy-duty type, designed for continuous industrial service. The system shall contain similar products of a single manufacturer, and shall consist of equipment models, which are currently in production. All equipment provided shall be of modular construction and shall be capable of field expansion.

E. All electronic/digital equipment shall be provided with radio frequency interference

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protection.

F. Electrical

1. Equipment shall operate on a 60 Hertz alternating current power source at a nominal 120 volts, plus or minus 10 percent, except where specifically noted. Regulators and power supplies required for compliance with the above shall be provided between power supply and interconnected instrument loop. Where equipment requires voltage regulation, constant voltage transformers shall be supplied.

2. With the exception for field device network connected devices, all electronic instrumentation shall utilize linear transmission signals of isolated 4 to 20 mA DC (milliampere direct current) capable of driving a load up to 750 ohms, unless specified otherwise. However, signals between instruments within the same panel or cabinet may be 1-5 VDC (volts direct current).

3. Outputs of equipment that are not of the standard signals as outlined, shall have the output immediately raised and/or converted to compatible standard signals for remote transmission. No zero based signals will be allowed.

4. All switches shall have double-pole double-throw contacts rated at a minimum of 600 VA, unless noted otherwise.

5. Switches and/or signals indicating an alarm, failure or upset condition shall be wired fail-safe to the SCADA system. A fail-safe condition is an open circuit when in an alarm state.

6. Materials and equipment shall be UL approved. Where components are not available with UL approval, integrate the device with ground fault protective devices, isolation transformers, fuses, or other protective equipment necessary to achieve compliance with UL 508 requirements.

7. Equipment shall be constructed so that when a power interruption occurs, the equipment specified hereunder resumes normal operation without manual resetting when power is restored unless otherwise noted.

8. All transmitter output signals shall include signal and power source isolation.

2.02 LIGHTNING/SURGE PROTECTION

A. General - Lightning/Surge protection shall be provided to protect the electronic instrumentation system from induced surges propagating along the signal and power supply lines from lightning, utility, or the internal plant electrical distribution system. The protection systems shall be such that the protective level shall not interfere with normal operation, but shall be lower than the instrument surge withstand level. Protection shall be maintenance free and self-restoring. Ground wires for all instrumentation device surge protectors shall be connected to a good earth ground.

B. Field Instrumentation Protection - Provide individual device protection for the 4-20 mA signal and, if 4 wire field instrument, the power supply of each field instrument mounted outside of the building or facility housing the control panel. Instruments mounted within

the structure as the associated control panel shall not require surge protection. Instruments shall be housed in a grounded metallic case. Device surge protectors shall be mounted within the instrument enclosure or a separate junction box coupled to the enclosure. Provide gas tube or metal oxide varisters (MOVs) surge protection devices as manufactured by Phoenix Contact, EDCO, Emerson Network Power Control Concepts, or equal.

C. Control Panel Power Feed – Provide protection of all 120 VAC power feeds into the control panels. Source voltage to cabinets/panels regardless of location (indoor or outdoor), shall be protected by isolation transformers and surge suppressors. Provide gas tube surge suppressors or metal oxide varisters (MOVs) located at the point where the 120V source supply enters the enclosure. Install the surge device to in strict compliance with the manufacturer's recommendation for maximum allowable circuit length between protective device and incoming circuit. Provide signal surge suppression devices as manufactured by Phoenix Contact, EDCO, Emerson Network Power Control Concepts, or equal.

D. 4-20 mA Signal Lines and Non-Fiber Based Data Highway Circuits – Provide protection on all signal and data highway circuits that leave a building or are routed external to a building. Provide gas tube surge arrestors, and Zener diode protectors. Circuit protection shall be provided at both ends of the signal or data highway lines within the control panel at one end and as close to the instruments or termination device as possible. Provide signal surge suppression devices as manufactured by Phoenix Contact EDCO, Emerson Network Power Control Concepts, or equal.

E. Inductive Loads – At a minimum, provide coil surge suppression devices, such as varistors, or interposing relays on all process controller outputs or switches rated 120 VA or less that drive solenoid, coil, or motor loads. .

F. Telephone Circuits - At a minimum, provide Telephone Company approved line protection units for all telephone lines used for telemetry or SCADA system use under this Contract.

2.03 TUBING AND FITTINGS

A. All instrument air header takeoffs and branch connections less than 2-in shall be 316 stainless steel.

B. All instrument shut-off valves and associated fittings shall be supplied in accordance with the piping specifications and all instrument installation details. The materials for fittings and valves shall be compatible with process fluids. Where metallic fittings and valves are compatible, wetted materials shall be Type 316 stainless steel.

C. The materials for instrument tubing shall be compatible with process fluids. Where metallic tubing is compatible, tubing shall be fully annealed ASTM A269 Seamless 316 grade free of OD scratches having the following dimensional characteristics as required to fit the specific installation:

1. 1/4-in to 1/2-in O.D. by 0.035 wall thickness.

2. 5/8-in to 1-in O.D. by 0.049 wall thickness.

3. 1-in O.D. by 0.065 wall thickness.

4. 1-1/4-in O.D. by 0.065 wall thickness.

5. 1-1/2-in O.D. by 0.083 wall thickness.

6. 2-in O.D. by 0.095 wall thickness.

D. All process connections to instruments shall be annealed 1/2-inches O.D. stainless steel tubing, Type 316.

E. All tube track shall be supported by stainless steel and installed as per manufacturer's installation instructions.

2.04 SPARE PARTS

A. Spare parts of the type and quantity as recommended by the manufacturer shall be furnished for all devices furnished under these sections.

B. All spare parts shall be wrapped in bubble wrap, sealed in a polyethylene bag complete with dehumidifier, then packed in cartons and labeled with indelible markings. Complete ordering information including manufacturer's part number, part ordering information including manufacturer, part number, part name, and equipment name and number(s) for which the part is to be used shall be supplied with the required spare parts. The spare parts shall be delivered and stored in a location directed by the Engineer.

C. As a minimum, furnish the following spare parts for control panels:

1. Timers - Five of each type installed.

2. Relays - Five of each type installed.

3. Fuses and circuit breakers - 10% (minimum of 10 fuses and 2 circuit breakers) of each type and size installed.

4. Light bulbs - 10% (minimum of 10) of each type installed.

5. Power supplies - one of each type installed.

6. Manufacturer's cables - one of each type installed.

7. Selector switches/pushbuttons - Two of each type installed including 5 contact blocks.

8. Surge protection devices - One of each type installed.

9. Provide one quart of touch-up paint, for each type and color used for all RTU cabinets, panels, and consoles supplied.

D. PLC components

1. One spare CPU of each type supplied

2. Two spare I/O modules of each type supplied

3. One spare specialty interface module of each type supplied

4. One spare remote I/O communication module of each type supplied

5. One spare communications module of each type supplied.

6. One spare power supply of each type supplied

7. One spare type of each communication cable supplied

## PART 3 EXECUTION

### 3.01 GENERAL INSTALLATION

A. Instrumentation and accessory equipment shall be installed in accordance with the manufacturer's instructions. The locations of equipment, transmitters, alarms and similar devices indicated are approximate only. Exact locations of all devices shall be as approved by the Engineer during construction. Obtain in the field, all information relevant to the placing of process control equipment and in case of any interference with other work, proceed as directed by the Contractor and furnish all labor and materials necessary to complete the work in an approved manner at no additional cost to the Owner.

B. The P&IDs and Drawings indicate the intent and not the precise nature of the interconnection between the individual instruments. Where indicated on the P&IDs or Drawings as not requiring installation, provide the instruments suitably packaged for storage.

C. Unless specifically indicated, direct reading or electrical transmitting instrumentation shall not be mounted on process piping. Instrumentation shall be mounted on instrument racks or stands. All instrumentation connections shall be provided with shutoff and drain valves. For differential pressure transmitters, 5-valve manifolds for calibration, testing and blow down service shall also be provided. For chemical or corrosive fluids, diaphragm seals with flushing connections shall be provided.

D. All piping and tubing to and from field instrumentation shall be provided with necessary unions, calibrations and test tees, couplings, adaptors, and shut-off valves. Process tubing shall be installed to slope from the instrument toward process for gas measurement service and from the process toward the instrument for liquid measurement service. Provide drain/vent valves or fittings at any process tubing points where the required slopes cannot be maintained.

E. Brackets and hangers required for mounting of equipment shall be provided. They shall be installed as shown and not interfere with any other equipment.

F. The shield on each process instrumentation cable shall be continuous from source to destination and be grounded at only one ground point for each shield.

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G. Installation of fiber optic cable within control panel and console assemblies. Refer to cable manufacturer's specifications for bend radius. Use cable breakout assembly as recommended by the cable manufacturer. Provide wire basket, strain relief as required to meet manufacturer's strain requirements.

H. Provide local electrical shutoffs and disconnects for all 4-wire field instruments requiring 120 VAC power. Electrical disconnects shall be suitably rated disconnect switches or manual motor starters as specified under Division 16.

I. Provide sunshades for equipment mounted outdoors in direct sunlight. Sunshades shall include standoffs to allow air circulation around the cabinet. Orient equipment outdoors to face to the North or as required to minimize the impact of glare on LED, LCD, or other digital readouts.

1. Loop Tuning - All electronic control stations incorporating PID controllers shall be tuned following device installation but prior to commencement of the field tests.

2. Optimal loop tuning shall be achieved either by auto-tuning software or manually by trial and error, Ziegler-Nichols step-response method, or other documented process tuning method. Assigning common PID factors for identical loops following field tuning of a single typical loop is acceptable.

3. Determine and configure optimal tuning parameters to assure stable, steady state operation of final control elements running under the control of field mounted, dedicated PID controllers or software based PID controllers residing as part of the programmable logic controller system. Each control loop that includes anti-reset windup features shall be adjusted to provide optimum response following startup from an integral action saturation condition.

4. Tune all PID control loops to eliminate excessive oscillating final control elements. Loop parameters shall be adjusted to achieve 1/4 amplitude damping or better. In addition, loop steady state shall be achieved at least as fast as the loop response time associated with critical damping.

5. Loop performance and stability shall be verified in the field following tuning by step changes to setpoint. Submit loop tuning methodology and verification as part of the final system documentation as specified in Part 1.

6. For cascade loops, tune both sets of controllers so that the cascade loop achieves the loop tuning characteristics specified herein.

END OF SECTION

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SECTION 13311

PLC HARDWARE AND SOFTWARE

PART 1 GENERAL

1.1 SCOPE OF WORK

A. This Section includes Programmable logic controllers for control of process equipment, process oriented machinery, and process systems.

1.2 QUALITY ASSURANCE

A. Manufacturer Qualifications: A qualified manufacturer shall be capable of providing training, parts, and coordination of emergency maintenance and repairs.

B. The programmable controller and all of the corresponding components within the family of controller products shall be manufactured by a company who regularly manufactures and services this type of equipment.

C. The manufacturer shall comply with ISO9001 standards for "Quality Systems- Model for Quality Assurance in Design/Development, Production, Installation, and Servicing".

D. The manufacturer shall provide complete technical support for all of the products. This shall include factory or on-site training, regional application centers, local or factory technical assistance, and a 24/7/365 technical support phone service.

1.3 DELIVERY, STORAGE, AND HANDLING

A. Deliver PLC components in packaging designed to prevent damage from static electricity and physical damage.

B. Store PLC equipment according to manufacturer requirements. At a minimum, store indoors in clean, dry space with uniform temperature to prevent condensation. Protect PLCs from exposure to dirt, fumes, water, corrosive substances, and physical damage. Also, protect the PLC from all forms of electrical and magnetic energy that could reasonably cause damage.

1.4 NOMENCLATURE AND IDENTIFICATION DEFINITIONS

A. AI: Analog Input

B. AO: Analog Output

C. Fixed I/O: A PLC style consisting of a fixed number of I/O, a processor, and a power supply all in one enclosure. Some fixed PLCs have limited expansion ability.

D. CPU: Central Processing Unit

E. DI: Discrete Input

F. Distributed I/O: Hardware specially designed to function as Remote I/O.

G. DO: Discrete Output

H. HMI: Human-Machine Interface

I. I/O Input and/or Output

J. Modular: A PLC style consisting of cards that are assembled to comprise a complete unit. All I/O, CPU, and Power Supply are dedicated cards. Typically, these cards are inserted into a chassis.

K. Master/Slave: Communication between devices in which one device, the master, controls all communications. The other devices, the slaves, respond only when queried by the master. Typically used in a Remote I/O application.

L. Peer to Peer: Communication between two or more devices, typically PLC's, in which each device can control the communication exchange.

M. PID: Control action, proportional plus integral plus derivative.

N. PLC: Programmable Logic Controller

O. Remote I/O: I/O that is located remotely from the processor. Remote I/O can communicate over a variety of communication protocols and can use standard rack based I/O, or special Remote I/O hardware referred to as Distributed I/O.

P. SCADA: Supervisory Control and Data Acquisition

1.5 SPARE PARTS

A. Supply spare parts equal to the greater of 25 percent or one field-replaceable system components unless noted otherwise.

B. At a minimum, provide the following:

1. Processors: Provide spare processor unit(s) for each unique processor installed.

2. Memory Cards: Provide spares for each type of card installed.

3. I/O Cards: Provide spares for each unique I/O module type installed. Provide two or 25 percent of installed quantity, whichever is greater.

4. Network interface and communication modules: Provide spare communication modules for each unique communication module installed.

5. Specialty Modules: Provide as a minimum a spare of each type of module identified

6. PLC Power supplies: Provide spare power supplies for each unique power supply installed.

7. Chassis: Provide spare chassis for each unique chassis installed.

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8. Fixed PLCs: Provide spares for each unique type of PLC installed.

9. Miscellaneous components (including cables): Provide spares for each unique component installed.

10. Manufacturer recommended spares: Supply spare parts equal to at least one set.

C. All spare parts shall be packaged to prevent damage during long-term storage. Identified all packages with indelible markings on the exterior describing contents.

D. Provided complete ordering information including manufacturer, part number, part name, hardware and software revision levels, and equipment for which the part is to be used.

1.6 SPARE I/O

A. Each I/O drop and I/O location shall include at least 20 percent (minimum of four) points of each type (AI, AO, DI, and DO) for future use, regardless of whether any of those point types are used in that drop or location or not. The spares shall be the same type of I/O modules supplied.

B. Spare output points that require the use of an external relay shall be supplied with the external relay.

C. Regardless of the spare requirement, all installed unused points on all I/O modules shall be wired to terminal blocks in the order that they occur on the I/O modules. Unwired spares shall not be acceptable.

## PART 2 PRODUCTS

2.1 GENERAL

A. Provide Programmable Logic Controller equipment with the required memory and functional capacity to perform the specified sequence of operation with the scheduled input and output points.

B. Processor Systems shall include processor, power supply, input/output modules, communication modules, redundancy modules, and remote interface modules as required to meet system requirements.

C. Furnish products listed and classified by Underwriters Laboratories (UL), CSA, or FM approval as suitable for purpose specified and indicated.

D. All equipment and devices furnished hereunder shall be designed for continuous industrial service. The system shall contain products of a single manufacturer, insofar as possible, and shall consist of equipment models that are currently in production.

E. All equipment furnished shall be designed and constructed so that in the event of power interruption the systems shall go through an orderly shutdown with no loss of memory, and resume normal operation without manually resetting when power is restored.

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F. The PLCs shall communicate between the operator workstation and field-mounted transducers, switches, controllers, and process actuators. Communications protocol shall be completely transparent to process operators at the Human Machine Interface (HMI).

G. The PLC shall be capable of stand-alone operation in the event of failure of the communication link to the HMI subsystem.

H. Agency and environmental specifications:

1. Electrical supply voltage to the PLC shall be 120 Vac, plus or minus 15 percent, 48-63Hz. PLC system power supplies shall be fused for overload protection.

2. Vibration: 3.5 mm Peak-to-Peak, 5-9 Hz: 1.0G, 9-150\Hz. The method of testing is to be based upon IEC 68-2-6 and JIS C 0911 standards for vibration. The system is to be operational during and after testing. Vibration Rating of 2.0G maximum peak acceleration for 10 to 500Hz. in accordance with at least one of the following:

   a. Installed rating: DIN rail mounted PLC: 10-57 Hz, amplitude 0.075 mm, acceleration 25-100 Hz, and,

   b. Panel or plate mounted PLC: 2-25 Hz, amplitude 1.6mm, acceleration 25-200 Hz.

   c. In compliance with IEC 60068 and IEC 61131.

3. Shock: 15G, 11 msec. The method of testing is to be based upon IEC 68-2-27 and JIS C 0912 standards for shock. The system is to be operational during and after testing.

4. Temperature: All PLC hardware shall operate at an ambient temperature of 0 to +55 degrees C (+32 to +140 degrees F), with an storage ambient temperature rating of -25 to +70 degrees C (-40 to +185 degrees F).

5. Relative Humidity: The Programmable Controller hardware shall function continuously in the relative humidity range of 30 percent to 95 percent non-condensing.

6. Noise Immunity: The Programmable Controller system shall be designed and tested to operate in the high electrical noise environment of an industrial plant as governed by the following regulations: IEEE 472, IEC 801, MILSTD 461B, IEC 255-4, NEMA ICS 2-230.40, and ANSI/IEEE C-37.90A-1978.

7. Altitude:

   a. Operation: 0-6,500 feet

   b. Storage: 0-9,800 feet

8. Degree of protection: NEMA 1 (IP20)

9. All products shall have corrosion protection.

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I. All major assemblies and sub-assemblies, circuit boards, and devices shall be identified using permanent labels or markings indicating:

1. Modules product type such as analog or digital
2. Modules catalog number
3. Modules major revision number
4. Modules minor revision number
5. Module manufacturer vendor
6. Module serial number

J. All necessary cables shall be included. All cables and connectors shall be as specified by the manufacturer. Cables shall be assembled and installed per the manufacturer recommendations.

K. MANUFACTURERS

1. Provide all PLCs from a single manufacturer. If the PLC manufacturer has authorized third party vendors to provide modules that are compatible with their platforms, then products manufactured by these authorized third party vendors will be acceptable.
2. Provide the PLC system by one of the following:
   a. Rockwell Automation Allen Bradley SLC 5/05
   b. Schneider-Electric Modicon Quantum Series.
   c. Siemens S7 Series
   d. General Electric GE FANUC
   e. or equal

L. Central Processing Unit (CPU)

1. The CPU shall be, at a minimum, a 16-bit microprocessor that provides system timing and is responsible for scheduling I/O updates, with no user programming required to ensure discrete or analog update. It shall execute user relay ladder logic programs, communicate with intelligent I/O modules, and perform on-line diagnostics. The CPU shall consist of a single module which solves application logic, stores the application program, stores numerical values related to the application processes and logic, and interfaces to the I/O.
2. The CPU shall sample all the discrete and analog inputs and outputs including internal coils and registers, and service special function modules every scan. The CPU shall process the I/O with user program(s) stored in memory, then control the

outputs based on the results of the logic operation.

3. Supply the CPU with a battery-backed time of day clock and calendar.

4. The CPU family shall allow for user program transportability from one CPU model to another.

M. Diagnostics

1. All diagnostic information shall be accessible to the host communications interfaces and to the PLC program.

2. The PLC shall have indicators and on board status area to indicate the following conditions:

   a. CPU run

   b. CPU error or fault

   c. I/O failure or configuration fault.

   d. Battery good

   e. Communications indicator

N. Memory

1. The user program and data shall be contained in non-volatile battery backed memory.

2. Type: CMOS RAM program memory.

3. Memory Backup: lithium battery backup or Flash memory system capable of retaining all memory for a minimum of three months.

4. Backup Battery: The backup battery shall be capable of being replaced without disrupting memory integrity. Provide a visual indication of low battery voltage and a low battery alarm contact.

5. Flash Memory: Upon power loss, the PLC shall transfer internal memory to flash memory before the PLC powers down.

6. The operator should be able to backup volatile memory, including data and program logic onto a personal computer storage disk.

7. The operating system shall be contained in non-volatile firmware. The memory containing the operating system shall be field updateable via a separate update tool.

O. Programming Environment

1. Programming port: The PLC shall utilize a serial USB or Ethernet port for programming.

2. On-Line programming: Application programs may be modified or stored while the CPU is running, with minimal impact on the scan time.

3. Online programming including runtime editing

4. Supply all hardware and software necessary to program the CPU in these languages.

P. Communication Ports

1. The CPU shall be expandable and supplied with additional modules to support the required communication interfaces.

2.2 POWER SUPPLIES

A. The PLC shall have chassis mounted power supplies to power the chassis backplane, and provide power for the processor and applicable modules.

B. Power supplies shall have a clearly visible LED to indicate that the incoming power is acceptable and the output voltage is present.

C. Power supplies shall feature over-current and over-voltage protection and should be designed to operate in most industrial environments without the need for isolation transformers.

D. Power supplies shall be sized to accommodate the anticipated load plus 30%.

E. DC power supplies shall be capable of handling ripple up to 2.4V peak to peak.

F. AC Line Voltage rating of 85 to 265Vac, 47-63Hz

G. The power supplies shall allow for brown outs of at least ½ of a cycle, a harmonic rate of 10%, and will sustain continuous operation through momentary interruptions of AC line voltage of 10ms or less.

H. Automatically shut down the Programmable Controller system whenever its output power is detected as exceeding 125% of its rated power

I. Provide surge protection, isolation, and outage carry-over up to 2 cycles of the AC line

2.3 CHASSIS

A. Medium and large PLC models shall be chassis based.

B. All system and signal power to the CPU and support modules shall be distributed on the backplane. No interconnecting wiring between these modules via plug-terminated jumpers shall be acceptable.

C. All system modules, main and expansion chassis shall be designed to provide for free air flow convection cooling. No internal fans or other means of cooling, except heat sinks, shall be permitted.

D. All system modules including the processor shall be removable from the chassis or inserted in to the chassis while power is being supplied to the chassis without faulting the processor or damaging the modules.

E. Modules shall be designed to plug into a chassis and to be keyed to allow installation in only one direction. The design must prohibit upside down insertion of the modules as well as safeguard against the insertion of a module into the wrong slot or chassis via an electronic method for identifying a module. Electronic keying shall perform an electronic check to insure that the physical module is consistent with what was configured.

## 2.4 DISCRETE INPUT AND OUTPUT MODULES

A. General

1. Digital input and output modules shall provide ON/OFF detection and actuation.

2. The I/O count and type shall be as required to implement the functions specified plus an allowance for active spares, as noted below.

3. Modules shall be designed to be installed or removed while chassis power is applied.

4. Modules shall have indicators to display the status of communication, module health and input / output devices.

5. Each module shall have the following status indicators.

   a. The On/Off state of the field device.

   b. The module's communication status.

6. I/O modules shall contain a maximum of 16 points per module.

B. Module Specifications (120Vac Isolated Input Module)

1. Nominal Input Voltage of 120V ac

2. On-State Current of 15mA @132V ac, 47-63Hz maximum

3. Maximum Off-State Voltage of 20V

4. Maximum Off-State Current of 2.5mA

C. Module Specification (120Vac Isolated Output Module)

1. Each triac type discrete output shall have an associated interposing relay located in the same control panel. 120 VAC power for relay outputs shall be provided from the associated motor starter control circuit (when used with motor starters) or other 120 VAC source (when I/O is not associated with a particular motor starter).

2. Output Voltage Range of 74-265V ac, 47-63Hz

3. Output Current Rating:

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a. Per Point - 2A maximum @ 30 degrees C; 1.0A maximum @ 60 degrees C; Linear Derating

b. Per Module - 5A maximum @ 30 degrees C; 4A maximum @ 60 degrees C; Linear Derating

4. Surge Current Per Point of 20A for 43ms each, repeatable every 2s @ 60 degrees C

5. Minimum Load Current of 10mA per point

6. Maximum On-State Voltage Drop of 1.5V peak @2.0A and 6V peak @load less than 50mA

7. Maximum Off-State Leakage of 3mA per point

D. Module Specifications (Contact Output Module)

1. Output Voltage Range of 10-265V ac, 47-63Hz

2. Output Current Rating:

a. Resistive - 2A @ 125V ac

b. Inductive - 2A Steady State, 15A make @125V ac

3. Power Rating (Steady State) of 250VA maximum for 125V ac inductive output

4. Maximum Off-State Leakage of 0 mA per point

5. Configurable States

a. Fault Per Point - Hold Last State, ON or OFF

b. Program Mode Per Point - Hold Last State, ON or OFF

## 2.5 ANALOG INPUT AND OUTPUT MODULES

A. General

1. Analog input modules shall convert an analog signal that is connected to the module's screw terminals into a digital value. The digital value representing the magnitude of the analog signal shall be transmitted on the backplane. Analog output modules shall convert a digital value that is delivered to the module via the backplane into an analog signal on the module's screw terminals.

2. Modules shall be designed to be installed or removed while chassis power is applied.

3. Modules shall have indicators to display the status of communication, module health and input / output devices.

4. Each analog module shall provide both hardware and software indication when a module fault has occurred. Each module shall have an LED fault indicator and the

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programming software shall display the fault information.

5. Analog modules shall be software configurable through the I/O configuration portion of the programming software.

6. The following status shall be capable of being examined in ladder logic

   a. Module Fault Word – Provides fault summary reporting.

   b. Channel Fault Word – Provides under-range, over-range and communications fault reporting.

   c. Channel Status Words – Provides individual channel under-range and over-range fault reporting for process alarm, rate alarms and calibration faults.

7. The 24 VDC power for analog instrument loops shall be provided as a part of the system. The 24 VDC power supply shall be derived from the 120 VAC input power circuit to the PLC. The field side of the 24 VDC power sources(s) shall have individual or grouped (of logically associated circuits) fusing and be provided with a readily visible, labeled blown fuse indicator.

B. Isolated Analog Input Module

1. Input Range of 0-20 mA

2. Resolution of approximately 16 bits across range

3. Input Impedance of Greater than 249 Ohms

4. Overvoltage Protection: 8V ac/dc with on-board current resistor

5. Normal Mode Rejection of 60dB at 60Hz

6. Common Mode Noise Rejection of 120dB at 60Hz, 100dB at 50Hz

7. Isolation Voltage

   a. Channel to Channel - 100% tested at 1700V dc for 1s based on 250V ac

   b. User to System - 100% tested at 1700V dc for 1s based on 250V ac

C. Isolated Analog Output Current Module

1. Output Current Range of 4 to 20 mA

2. Current Resolution of 12 bits across 20 mA

3. Open Circuit Detection – None

4. Output Overvoltage Protection - 24V ac/dc maximum

5. Output Short Circuit Protection – 20 mA or less (electronically limited)

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6. Calibration Accuracy - Better than 0.1% of range from 4mA to 20 mA

7. Calibration Interval - 12 months typical

2.6 COMMUNICATION INTERFACES

A. The PLC will be capable of the following communication protocols as shown on the drawings:

1. 10BASE-T/100BASE-TX Ethernet communication.

2. Modbus (RTU and ASCII) for up to 247 slaves

B. When required provide an Communications Interface Module mounted in the chassis or the equivalent port directly on the CPU.

2.7 PLC SOFTWARE

A. The integrator shall provide a PLC configuration and application development software package complete with documentation and disks. The PLC software package and associated licensing and/or activation shall be installed on the computers shown on the drawings.

B. The software package shall allow on-line/off-line program development, annotation, monitoring, debugging, uploading, and downloading of programs to the PLCs.

C. All required hardware (including cables, cable adapters, etc.) for connection to PLCs shall be furnished.

D. All software licenses required to achieve the functionality described in the Specifications shall be provided.

E. The software package shall include a software license agreement allowing the Owner the right to use the software as required for any current or future modification, documentation, or development of the PLCs furnished for this project.

F. The software shall be Microsoft Windows-based and run on the supplied computers.

G. The software shall include a security feature to prevent unauthorized personnel from modifying and downloading the programs.

H. Provide an I/O simulator which allows the PLC application load program to be tested on a PC with simulated analog and digital inputs and outputs, allowing I/O testing and debugging to be performed in a safe, isolated environment without the need for running the PLC CPU and process I/O boards.

PART 3 EXECUTION

3.1 GENERAL INSTALLATION

A. Maintain area free of dirt and dust during and after installation of programmable controller products.

B. Anchor PLCs within enclosures as recommended by the PLC manufacturer.

C. Ventilation slots shall not be blocked, or obstructed by any means.

D. Examine areas, surfaces, and substrates to receive PLCs for compliance with requirements, installation tolerances, and other conditions affecting performance. Proceed with installation only after unsatisfactory conditions have been corrected.

E. Install in accordance with manufacturer's instructions.

F. Unload, unpack and transport equipment to prevent damage or loss.

G. Replace damaged components as directed by Engineer.

3.2 PANEL LAYOUT

A. Coordinate size and configuration of enclosure to meet project requirements. Drawings indicate maximum dimensions for PLCs, minimum clearances between PLCs, and adjacent surfaces and other items.

B. Comply with indicated maximum dimensions and clearances; or with PLC vendors required distances if they are greater then the distances indicated.

C. Provide spacing around PLC as required by the PLC manufacturer to insure adequate cooling. Insure that the air surrounding the PLC has been conditioned to maintain the required temperature and humidity range.

1. Wires entering and exiting PLC components shall be sized to comply with the PLC manufacturers requirements. Doors on all components shall be able to be fully closed when all the wires are installed.

2. For chassis mounted PLCs, no wiring, wire ducts, or other devices shall obstruct the removal of cards from the rack.

3. PLC lights, keys, communication ports, and memory card slots shall be accessible at all times. Lights shall be visible at all times when enclosure door is opened.

D. Control panel designer shall provide independent line fuses or circuit breakers, per the PLC manufacturer recommendation, for each power supply, input module, output module, and other modules with separately derived power requirements.

E. Control panel designer shall insure that communication signals, 4-20mA signals (including those with embedded HART), are properly conditioned for the PLC and protected from all sources of radiated energy or harmonics.

F. Each PLC (including all I/O) shall be powered from the UPS power conditioning system.

G. Provide all required cables, cords, and connective devices for interface with other control system components.

END OF SECTION

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SECTION 13320

CONTROL AND DATA NETWORK EQUIPMENT

PART 1 GENERAL

1.1 SCOPE OF WORK

A. Furnish all labor and materials required and installed. Complete as shown on the Drawings and as specified herein.

B. The System Integrator shall furnish the labor and materials required to install and bring into operation the control and data network as shown on the Drawings and specified herein.

C. The network shall be capable of supporting communications between all servers, operator workstations, PLCs, RTUs, and other communication devices as shown on the system architecture block diagram(s). The System Integrator shall furnish all necessary cables, face plates, connectors, modems, transceivers, repeaters, modules; splice kits, etc. required for a complete and operational network. The system architecture diagram(s) are for network understanding only. Some communication devices maybe required for network operation, which may not be explicitly shown on the Drawings. The system shall be designed to accommodate an increase of 100 percent of network nodes.

PART 2 PRODUCTS

1.2 GENERAL

A. The use of a manufacturer's name and model or catalog number is for the purpose of establishing the standard of quality and general configuration desired.

1.3 MANAGED ETHERNET SWITCHES

A. General

1. Provide a managed Ethernet switch(s) for connection to the control network backbone as shown in the Drawings and specified herein.

B. Physical Features

1. Fiber uplinks: 2 x 100/1000 FX ports, minimum

2. Copper ports: 16 x 10/100 TX RJ45 ports, minimum

3. Operating temperature: 32 to 130 degrees f

4. Power: 24 VDC redundant power supply inputs

5. Enclosure: Metal case, DIN-rail mountable

6. Rating: UL Class 1, Division 2 Groups A, B, C, and D

C. Network Features

1. Full duplex on all port
2. Auto negotiation and manual configurable speed and duplex
3. Wire speed switching fabric
4. IEEE 802.1w RSTP
5. 1GMP snooping
6. 1GMP filtering
7. Configuration password protected
8. Configuration backup capability required
9. SNMP V3

D. Acceptable Manufacturers

1. Cisco
2. Moxa
3. Hirschmann
4. Or equal

1.4 UNMANAGED ETHERNET SWITCHES

A. General

1. Provide unmanaged Ethernet switch(s) for connection to the control network backbone as shown in the Drawings and specified herein.

B. Physical Features

1. Copper ports: 4 – 10/100 TX RJ45 ports, minimum
2. Operating temperature: 32 to 130 degrees f
3. Power: 24 VDC
4. Enclosure: Metal case, DIN-rail mountable
5. Rating: UL Class 1, Division 2 Groups A, B, C, and D

C. Network Features

1. Auto sensing duplex and speed
2. LED link/activity status indication

D. Acceptable Manufacturers

1. Phoenix contact
2. N-Tron
3. Moxa
4. Or equal

1.5 ETHERNET MEDIA CONVERTERS

A. General

1. Provide Ethernet media converter(s) as shown in the Drawings and specified herein.

B. Physical Features

1. RJ45 ports: 10/100BaseTX to 100BaseTX
2. Fiber uplinks: 100BaseTX to 100BaseFX (ST/SC connectors)
3. Fiber optics: Multi- or single-mode capability as shown in the Drawings
4. Operating temperature: 32 to 130 degrees f
5. Power: 24 VDC
6. Enclosure: DIN-rail mountable

C. Acceptable Manufacturers

1. Phoenix Contact
2. N-Tron
3. Moxa
4. Or Equal

1.6 WIRES AND CONNECTORS

A. Ethernet 10/100/1000 BASE-T/TX Cable.

1. The unshielded twisted pair cable shall be designed for use with a high speed (10/100/1000 Mbps) Ethernet 10/100/1000 BASE-T/TX communications network. The twisted pair cable shall have a nominal impedance 100 ohms at one MHz, a maximum attenuation of 8 dB per 1000 feet at one MHz. The twisted pair cable must

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have frequency tested up to 250 MHz or more. The twisted pair cable shall be plenum rated and shall have a minimum of four 23 AWG solid copper conductor pairs. All 10/100/1000 BASE-T/TX (RJ-45) terminations on the twisted pair cable shall be done in a professional and workman like manner. Terminations shall provide for proper strain relief on the cable jacket. Strain relief on the wire and/or wire insulation shall not be acceptable.

PART 3 EXECUTION

END OF SECTION

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SECTION 13321

FIBER OPTIC CABLING AND EQUIPMENT

PART 1 GENERAL

1.01 SCOPE OF WORK

A. The Work of this Section includes providing a fiber optic communications infrastructure including, but not limited to, fiber optic cable (FOC), patch panels, terminations, testing, and implementation.

B. The Work includes testing individual fiber cables installed under this Contract, and testing a completed fiber optic communications network.

1.02 QUALITY ASSURANCE

A. The cable manufacturer shall be ISO9001 certified and registered.

B. The fiber optic cabling system materials furnished under this Section shall be provided by Fiber Optic Suppliers who have been providing these types of materials for the past three years. The Fiber Optic Suppliers shall provide personnel capable of providing technical assistance during installation.

C. The installation of fiber optic cabling system materials furnished under this Section shall be performed by an installation Contractor who has been installing these types of materials and systems for the past three years.

D. Supplier must furnish five working installation references.

1.03 DELIVERY, STORAGE, AND HANDLING

A. The cable shall be packaged in cartons and/or wound on spools or reels. Each package shall contain only one continuous length of cable. The packaging shall be constructed so as to prevent damage to the cable during shipping and handling.

B. When the length of an order requires a large wooden reel, the cable will be covered with a three-layer laminated protective material. The outer end of the cable shall be securely fastened to the reel head so as to prevent the cable from becoming loose in transit. The inner end of the cable shall project into a slot in the side of the reel or into housing on the inner slot of the drum, in such a manner and with sufficient length to make it available for testing.

C. Test tails shall be at least two meters long. The inner end shall be fastened so as to prevent the cable from becoming loose during shipping and installation. Reels shall be permanently marked with an identification number that can be used by the manufacturer to trace the manufacturing history of the cable and fiber.

D. Wooden reels shall be plainly marked to indicate the direction in which it should be rolled to prevent loosening of the cable on the reel.

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E. All fiber optic cables shall be attenuated tested. The attenuation of each fiber shall be provided with each cable reel by the manufacturer.

F. The attenuation shall be measured at 1310 nm and 1550 nm for single-mode fibers and 850nm and 1300nm for multimode fiber cables after received on site. The manufacturer shall submit the test results prior to installation of the cable.

G. Packaging

1. The completed cable shall be packaged for shipment on non-returnable wooden reels. It is the responsibility of the Contractor to determine all required cable lengths.

2. Top and bottom ends of the cable shall be available for testing.

3. Both ends of the cable shall be sealed to prevent the ingress of moisture.

4. Each reel shall have a weatherproof reel tag attached identifying the reel and cable. The reel tag shall include the following information:

a. Cable Number Gross Weight.

b. Shipped Cable Length in Meters.

c. Product Number.

d. Date Cable was Tested.

e. Cable Length Markings Item Number.

H. Each cable shall be accompanied by a cable data sheet.

## PART 2 PRODUCTS

### 2.01 GENERAL MATERIALS

A. Cabinets: cabinets shall be provided as indicated on the contract Drawings.

B. Provide tight buffered cables that are not gel filled and are suitable for indoor/outdoor applications. These cables shall be flame retardant for indoor applications and water and fungus resistant for outdoor applications.

C. Optical Fiber Characteristics

1. All fibers in the cable must be usable fibers and meet required specifications.

2. Each optical fiber shall consist of a doped silica core surrounded by a concentric silica cladding. The fiber shall be matched clad design.

3. Multi-mode: Provide multimode, optical glass fiber compatible with LED or laser based transmission systems with the following fiber types:

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D. Manufacturers

1. Corning Cable Systems Corp.

2. CommScope.

3. Belden Cable.

4. Or equal.

2.02 STANDARD 62.5/125 µM FIBER

A. The multimode fiber shall meet EIA/TIA-492AAAA-A-1997, "Detail Specification for 62.5-□m Core Diameter/125□m Cladding Diameter Class Ia Graded Index Multimode Optical Fibers."

Geometry

| | | |
|---|---|---|
| Core Diameter | (µm) | 62.5 ± 3.0 |
| Core Non-Circularity | | ≤ 5 % |
| Cladding Diameter | (µm) | 125.0 ± 2.0 |
| Cladding Non-Circularity | | ≤ 1.0 % |
| Core-to-Cladding Concentricity | (µm) | ≤ 1.5 |
| Coating Diameter | (µm) | 245 ± 5 |
| Colored Fiber Nominal Diameter | (µm) | 253 - 259 |

Optical

| | | |
|---|---|---|
| Cabled Fiber Attenuation | (dB/km) | |
| 850 nm | | ≤ 3.5 |
| 1300 nm | | ≤ 1.0 |
| Point Discontinuity | (dB) | |
| 850 nm | | ≤ 0.2 |
| 1300 nm | | ≤ 0.2 |
| Cabled Effective Modal Bandwidth[1)] | (MHz•km) | |
| 850 nm | | ≥ 220 |
| IEEE 802.3 GbE Distance | (m) | |
| 1000BASE-SX Window (850 nm) | | up to 300 |
| 1000BASE-LX Window (1300 nm) | | up to 550 |
| OFL Bandwidth | (MHz•km) | |
| 850 nm | | ≥ 200 |
| 1300 nm | | ≥ 500 |
| Numerical Aperture | | 0.275 ± 0.015 |

1) As predicted by RML BW, per TIA/EIA 455-204 and IEC 60793-1-41, for *intermediate performance laser based systems* (up to 1 Gb/s).

2.03 LOOSE TUBE FIBER OPTIC CABLE (INDOOR/OUTDOOR)

A. Cable shall be flame-retardant, UV stabilized, fully water blocked with dielectric central

member for use in indoor/outdoor applications. The buffer tubes shall be gel-free. Each buffer tube shall contain a water-swellable yarn for water-blocking protection. Cable manufacturer shall have a minimum of 20 years in manufacturing optical fiber cable in order to demonstrate reliable field performance. Cable and fiber manufacturer shall be the same company to ensure long-term reliability of the cabled fiber and to ensure the availability of fully integrated technical support. Cable shall be suitable for installation in duct, aerial, and riser environments. Cable shall meet UL OFNR specifications and not require transition splicing upon building entry in order to meet fire codes.

B. Optical fibers shall be placed inside a buffer tube.

C. Each buffer tube shall contain up to 12 fibers.

D. In buffer tubes containing multiple fibers, the colors shall be stable across the specified storage and operating temperature range and not subject to fading or smearing onto each other or into the gel filling material. Colors shall not cause fibers to stick together.

E. Buffer tubes shall be kink-resistant within the specified minimum bend radius.

F. Fillers may be included in the cable core to lend symmetry to the cable cross-section where needed.

G. The central anti-buckling member shall consist of a glass-reinforced plastic rod. The purpose of the central member is to prevent buckling of the cable.

H. The cable core shall contain a water-blocking material. The water-blocking material shall be non-nutritive to fungus, electrically non-conductive, and homogenous. It shall also be free from dirt and foreign matter and shall be readily removable with conventional non-toxic solvents. Cable shall contain water-blocking threads between tubes.

I. The cable shall contain at least one ripcord under the sheath for easy sheath removal.

J. Tensile strength shall be provided by a combination of high tensile strength dielectric yarns.

K. The high tensile strength dielectric yarns shall be helically stranded evenly around the cable core.

L. All dielectric cables (with no armoring) shall be sheathed with medium density polyethylene (MDPE). The minimum normal jacket thickness shall be 1.4 mm. Jacketing material shall be applied directly over the tensile strength members and water-blocking material. The polyethylene shall contain carbon black to provide ultraviolet light protection and shall not promote the growth of fungus.

2.04 CABLE CONSTRUCTION

A. Riser Cables

1. Riser cables up to 24 fibers: In cables with more than one fiber, the fibers shall be stranded around a dielectric member and surrounded by layered aramid yarns. The aramid yarns shall serve as the tensile strength member of the cable. A ripcord may be applied between the aramid yarns and the outer jacket to facilitate jacket removal. The

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outer jacket shall be extruded over the aramid yarns for physical and environmental protection.

2. Riser cables with more than 24 fibers: The buffered fibers shall be grouped into six fiber subunits. In each subunit, the individual fibers shall be stranded around a dielectric central member and surrounded by layered aramid yarns. A ripcord shall be incorporated in the subunit design to facilitate access to the individual fibers. The subunit jacket shall be extruded over the aramid yarns for additional physical and environmental protection. The subunits shall be stranded around a dielectric central member. A ripcord shall be inserted beneath the outer jacket to facilitate jacket removal. The outer jacket shall be extruded around the units for physical and environmental protection.

B. Plenum Cables

1. Plenum cables up to 24 fibers: The fibers shall be stranded around a dielectric member and surrounded by layered aramid yarns. The aramid yarns shall serve as the tensile strength member of the cable. A ripcord may be applied between the aramid yarns and the outer jacket to facilitate jacket removal. The outer jacket shall be extruded over the aramid yarns for physical and environmental protection.

2. Plenum cables with 24 to 72 fibers: The buffered fibers shall be grouped into six fiber subunits. In each subunit, the individual fibers shall be stranded around a dielectric central member and surrounded by layered aramid yarns. A ripcord shall be incorporated in the subunit design to facilitate access to the individual fibers. The subunit jacket shall be extruded over the aramid yarns for additional physical and environmental protection. The subunits shall be stranded around a dielectric central member. A ripcord shall be inserted beneath the outer jacket to facilitate jacket removal. The outer jacket shall be extruded around the units for physical and environmental protection.

3. Plenum cables with more than 72 fibers: The buffered fibers shall be grouped into twelve fiber subunits. In each subunit, the individual fibers shall be stranded around a dielectric central member and surrounded by layered aramid yarns. A ripcord shall be incorporated in the subunit design to facilitate access to the individual fibers. The subunit jacket shall be extruded over the aramid yarns for additional physical and environmental protection. The subunits shall be stranded around a dielectric central member. A ripcord shall be inserted beneath the outer jacket to facilitate jacket removal. The outer jacket shall be extruded around the units for physical and environmental protection.

4. The strength member shall be a high modulus aramid yarn. The aramid yarns shall be helically stranded around the buffered fibers. Non-toxic, non-irritant talc shall be applied to the yarn to allow the yarns to be easily separated from the fibers and the jacket.

C. Cable Jacket

1. The jacket shall be continuous, free from pinholes, splits, blisters, or other imperfections. The jacket shall have a consistent, uniform thickness; jackets extruded under high pressure are not acceptable. The jacket shall be smooth, as is consistent with the best commercial practice. The jacket shall provide the cable with a tough, flexible, protective coating, able to withstand the stresses expected in normal installation and service.

2. The cable and subunit jacket color shall be orange for cables containing multimode

fibers.

3. The cable and subunit jacket color shall be yellow for cables containing single-mode fibers.

4. For cables with more than two fibers, the cable jacket shall be designed for easy removal without damage to the optical fibers by incorporating a ripcord under each cable jacket. Non-toxic, non-irritant talc shall be applied to the aramid yarns to allow the yarns to be easily separated from the fibers and the jacket.

5. The nominal thickness of the cable outer jacket shall be sufficient to provide adequate cable protection while meeting the mechanical, flammability, low smoke, and environmental test requirements of this document over the life of the cable.

D. The cable shall be all-dielectric.

2.05 CABLE IDENTIFICATION

A. The individual fibers shall be color coded for identification. The optical fiber color coding shall be in accordance with EIA/TIA-598, "Color Coding of Fiber Optic Cables." The coloring material shall be stable over the temperature range of the cable, shall not be susceptible to migration, and shall not affect the transmission characteristics of the optical fibers. Color coded buffered fibers shall not adhere to one another. When fibers are grouped into individual units, each unit shall be numbered in the unit jacket for identification. The number shall be repeated at regular intervals.

B. The outer cable jacket shall be marked with the manufacturer's name or UL file number, date of manufacture, fiber type, flame rating, UL symbol, and sequential length markings every two feet. The markings shall be in contrasting color to the cable jacket.

2.06 CABLE TESTING REQUIREMENTS

A. The Contractor shall submit laboratory test reports on representative samples of similar cable design to demonstrate compliance prior to cable installation.

2.07 FIBER CABLE TERMINATIONS, CONNECTORS, AND CABLE ASSEMBLIES

A. Pigtail Splicing

1. For termination of fiber cables at a termination or connector panel (patch panel), with one end of a piece of cable preconnectorized and the other end unterminated for splicing to the cable that needs to be terminated. Splicing and connectors shall meet the requirements listed in this Section.

2. A splice/termination tray shall house the splices and serve to fully protect excess lengths of loose tube fibers from exposure. Splice tray shall be compatible with the selected patch panel and installed for easy access to the spliced cable sections.

3. Pigtail assemblies shall match fiber cable type and model and shall be as manufactured by Corning Cable Systems or equal.

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B. Buffer Tube Fan-Out Kits

1. Individual fibers within a loose tube cable with 250 µm coated fibers shall use a fan-out kit to maintain flexibility and ease of handling fibers within a termination cabinet. Fan-out kits shall be installed in the patch panel enclosures to transition the loose tube fibers to ruggedized tight-buffered fiber pigtail cables. Optical fusion splices shall connect the loose tube fibers to the tight-buffered pigtail cables. The optical splice loss shall comply with the specifications for optical splices. Splice protection sleeves shall be employed on all splices to protect the splices.

2. The tight-buffered pigtails shall be factory-preconnectorized with STTM connectors as specified.

C. Connectors (Cable Assemblies)

1. The fiber optic communications system shall utilize stainless steel ST style connectors for all fiber optic connections. SC style connectors will be acceptable only if ST style connectors are not compatible with the equipment being provided. The connectors shall be designed for use with 50/62.5/125/250 micron cable. Each connector shall cause a maximum signal attenuation of 1.6 dB.

   a. Insertion loss (typical): 0.3 dB

   b. Durability (mating cycles): 500 (minimum)

   c. Repeatability: Less than 0.2 dB

   d. Operating Temperature: 0 to plus 60 degrees C]

2. After termination with connectors, the fiber ends must be visually inspected at a magnification of not less than 100 power for multimode and 200x for single mode to check for cracks or pits in the endface of the fiber.

3. Connectors shall have a maximum allowable connection loss of 0.3 dB per mated pair, as measured per EIA-455-34. No index-matching gel is to be used; dry interfaces only.

4. Each connector shall be of the industry standard ST type compatible; designed for single-mode and multimode tolerances; shall meet or exceed the applicable provisions of EIA-455-5, 455-2A, and 455-34; and shall be capable of 100 repeated ratings with a maximum loss increase of 0.1 dB. Connectors shall incorporate a key-way design and shall have a Zirconia ceramic ferrule. Connector bodies and couplings shall be made of corrosion-resistant and oxidation-resistant materials such as nickel-plated zinc, designed to operate in humid environments without degradation of surface finishes. Connectors shall be capable of operating in a range of -40 to 80 degrees C.

5. Manufacturers

   a. Corning Cable Systems, Hickory, NC

   b. AMP, Inc., Harrisburg, PA

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c. 3M Telecom Systems Group, Austin, TX or equal.

D. Fiber Optic Patch Cables

1. Fiber optic patch cable shall be two-fiber zipcord 50/62.5/125 core/clad micron multimode riser rated cable.

2. Installation of patch cables shall include all spares and observe the minimum fiber bend radius and strain relief.

2.08 FIBER OPTIC TERMINATION PATCH PANELS

A. General

1. Patch panels shall be suitable for wall mounting, comprised of internal mounting plate, cable holders, slack cable take up/organizer blocks, patch block with connectors, and ground lugs as indicated. Panels shall be NEMA 4X, 316 stainless steel construction for outdoors; and NEMA 12, 316 stainless steel or fiberglass for indoor use. Patch panels shall be suitable for multimode system operation at 800 and 1300 nanometers. Patch panels shall be suitable for ST connectors. The patch panels shall be sized to handle the number of fibers as required. All fibers shall be terminated in the patch panel.

2. Where shown on the plans or in the related specification Sections, the fiber optic cable shall terminate inside a communications cabinet on a termination patch panel. All fiber sub-cables within the exposed buffer tube shall be terminated with fan-out kits with preconnectorized pigtails. The patch panel shall have a fiber capacity equal to the total number of fibers (connected and spare) for all cables to be connected.

3. Unused buffer tubes shall be uncut and looped within the patch panel for continuous routing of the fiber buffer tube within the cable assembly.

4. Patch panels shall be designed for either rack mounting on a standard equipment rack or housed in an enclosure for direct wall mounting. The patch panel shall contain "ST" type bayonet or LC couplings. All unused couplings shall have protective dust covers. All panels shall be furnished with locking doors.

5. Factory-terminated, tight-buffered, aramid-reinforced fiber optic jumper assemblies or interconnect cables, standard 3.0-mm O.D., shall connect the optical cable terminations to the patch panel couplings.

6. The termination patch panel shall be equipped with a suitable means for routing and securing of cables, and shall provide a suitable means of protection for the mounted fiber connectors to prevent damage to fibers and connectors during all regular operation and maintenance functions. All cables shall be provided with strain relief. Bend diameters on cable fibers and jumpers must be greater than four inches at all times to ensure optical and mechanical integrity of the optical fibers.

7. Termination panels shall be equipped with splice trays (where applicable) and holders for pigtail and through fiber splicing.

8. Termination panels shall be provided with all hardware, options, and accessories to

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provide for a complete installation of the fiber optic system.

9. Panels shall be as manufactured by Corning Cable Systems LANscape or equal.

B. Rack Mount Fiber Distribution Center (FDC) Splice Housing

1. A rack-mountable Fiber Distribution Center splice housing shall be provided for pigtail splicing and through fiber splicing equipment.

2. The splice housing shall be compatible with the FDC for interconnection of the splicing equipment with the fiber cable management, termination, and distribution rack equipment.

3. Splice trays shall be provided for pigtail splicing.

4. The splice housing shall be sized and equipped with sufficient capacity to terminate and feed through all required fiber cable, plus an additional 20 percent.

5. Provide one spare splice tray.

6. Splice housing shall be Corning Cable Systems LANscape CSH series.

C. Rack Mount Fiber Distribution Center (FDC)

1. The Fiber/Network equipment rack shall be supplied with two rack-mountable Fiber Distribution Centers (FDCs) capable of 48 ST fiber termination points each. The connector center shall be 19" rack-mountable and provide for internal fan-out, splicing, and connection of the fiber optic cable to front panel ST connection patch panel.

2. The FDC shall provide backbone and intermediate connects and cable strain relief for a maximum of five fiber cable systems. The front shall be swing open construction with keyed latch mechanism.

3. The FDC shall be compatible for interconnection with the FDC Splice Housing and provide space and support the addition of fiber cable splice trays for future cable connection and termination.

4. The Fiber Connection Center shall be Corning Cable Systems LANscape CCH series.

D. Wall/Panel Mount Fiber Distribution Center (WDC)

1. The field-mounted fiber termination enclosures shall be supplied with a Wall Mount Fiber Distribution Center (WDC) capable of 48 ST fiber termination points. The distribution center shall be panel-mounted and provide for internal fan-out, splicing, and connection of the fiber optic cable to the patch panel assemblies.

2. Splice trays shall be provided for pigtail splicing. The WDC shall be provided with pass-thru splice trays for continuation of the fiber cable system to additional sites.

3. Provide one spare splice tray.

4. The WDC shall provide space and support the addition of future fiber cable splice trays.

5. The Wall Mount Fiber Distribution Center shall be Corning Cable Systems LANscape (WCH) series.

PART 3 EXECUTION

3.01 GENERAL

A. Provide all material, equipment, and labor to test and integrate the fiber optic system as indicated and as specified.

B. Installation shall comply with EIA/TIA Standards 568 and 569.

C. Fiber optic cables shall be continuous from component to component. Intermediate fiber splices shall not be allowed.

D. Provide delivery, storage, and handling of materials and equipment in accordance with Section 01600.

3.02 IDENTIFICATION

A. Label each termination point.

B. Label each cable, buffer tube, and fiber with permanent waterproof typewritten tags.

3.03 PHYSICAL CHECKOUT

A. General Procedures

1. Conduct physical checkout of the fiber optic data highway network.

2. Physical checkout shall be performed prior to functional testing.

B. Check Procedures

1. Verify that fiber optic cable reels have been off-loaded from truck carefully and not damaged.

2. Submit to the Engineer all test data provided by the fiber manufacturer.

3. Verify that the optical fibers of the cable assembly are the type and quantity as specified and as recommended by the Instrumentation System Supplier.

4. Verify that cable construction is the type specified.

5. Verify that fiber optic patch panels have been installed plumb and level at locations indicated.

6. Verify that optical fiber connections or terminations within patch panels and splice closures are in accordance with cable manufacturer's recommendations.

3.04 FIBER OPTIC CABLE TESTING

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A. General: The Contractor shall perform pre-installation and post-installation FOC tests. The Construction Manager shall be notified a minimum of 10 days in advance so that these tests are witnessed. All test equipment shall be traceable to NIST standards.

B. Test equipment: The Contractor shall use the following to perform pre-installation and post-installation FOC tests:

1. Optical time domain reflectometer (OTDR). The OTDR shall be laser precision, and be able to test single mode or multimode systems with a visual fault locator. The OTDR shall be as manufactured by Corning, Agilent Technologies, Fluke Networks, or equal.

C. Pre-installation Tests

1. The purpose of these tests is to perform acceptance tests on the cable prior to installation to verify that the cable conforms to the manufacturer's specifications; is free of defects, breaks, and damages by transportation and manufacturing processes; and to provide baseline readings in dB.

2. Prior to removal of each cable from the delivery reel, all optical fibers within the cables shall be tested by the Contractor using an OTDR. The OTDR tests shall consist of end-to-end length and fiber attenuation (dB/km) measurements to ensure proper performance of the fiber optic cable. The tests shall be performed from both ends of each fiber to ensure complete fiber continuity within the cable structure.

3. Pre-installation, "on-reel" test results shall be compared with the manufacturer's test report delivered with the cable. Gross dissimilarities shall be noted and remedied between the Contractor and manufacturer. In all cases, all fibers must meet the optical attenuation specifications prior to cable installation.

4. The Contractor shall perform tests on all reels of cable. The Construction Manager shall be notified a minimum of 15 days prior to any test.

5. The Contractor shall document each test and submit the report to the Construction Manager for review. Documentation shall consist of both hard copy and 3.5 inch electronic disk complete with all application software.

6. Cable shall not be installed until the Construction Manager has reviewed the test report.

7. Maximum allowable attenuation is 0.5 dB/km at 1310 and 1550 nm. The Contractor shall replace any cable in which any fiber does not meet this requirement.

D. Post-installation tests: After FOC has been installed and connectorized, the following tests shall be performed:

1. Visually inspect terminal connectors for out-of-round condition and surface defects such as micro-chips and cracks using a 200X (minimum) inspection microscope.

2. A recording OTDR shall be used to test for end-to-end continuity and attenuation of each optical fiber. The OTDR shall have an X-Y plotter to provide a hard copy record of each trace of each fiber. The OTDR shall be equipped with sufficient internal masking to allow the entire cable section to be tested. This may be achieved by using an optical fiber

pigtail of 30 feet or more to display the required cable section.

3. The maximum permissible end-to-end loss shall be 0.5 dB/km. The Contractor shall replace any cable in which any fiber does not meet this requirement.

4. The OTDR shall be calibrated for the correct index of refraction to provide proper length measurement for the known length of reference fiber.

5. A transmission test shall be performed with the use of a 1310 and 1550 nm stabilized light sources and 1310 nm/1550 nm power meters for SMF. This test shall be conducted in both directions on each fiber of each cable.

6. Hard and electronic copies of test documentation shall be submitted to the Construction Manager. The documentation shall include:

   a. The trace plot.

   b. Index.

   c. dB/km loss.

   d. Cable length.

   e. Date and time of test.

   f. Wavelength.

   g. Pulse width.

   h. The test site.

   i. Cable ID.

   j. Fiber number and type.

   k. Operator's initials.

7. The Contractor shall compare the pre-installation test results to the post-installation results. If a deviation of greater than one dB occurs, the Construction Manager shall be notified in writing by the Contractor, and the cable shall be removed and replaced at no additional cost to the OWNER.

8. Upon completion of the previous tests, all FOC coils shall be secured with ends capped to prevent intrusion of dirt and water.

E. Certification of completion of pre- and post-fiber installation testing including test results shall be provided to the Engineer, Contractor, and Ozone Control System Supplier. Test results shall be submitted on paper in a binder, including results indicated in tables or a spreadsheet. Test results that exceed specification limits shall be noted. The electronic copy shall be included in the binder.

F. Required OTDR Trace Information

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1. All traces shall display the entire length of cable under test, highlighting any localized loss discontinuities (installation-induced losses and/or connector losses). The trace shall display fiber length (in kilofeet), fiber loss (dB), and average fiber attenuation (in dB/km), as measured between two markers placed as near to the opposite ends of the fiber under test as is possible while still allowing an accurate reading. Care shall be taken to ensure that the markers are placed in the linear region of the trace, away from the front-end response and far-end Fresnel reflection spike. Time averaging shall be used to improve the display signal to noise ratio. The pulse width of the OTDR shall be set to a sufficient width to provide adequate injected power to measure the entire length the fiber under test.

2. If connectors exist in the cable under test, then two traces shall be recorded. One trace shall record the fiber loss (dB) and average attenuation (dB/km) of the entire cable segment under test, including connectors. The second trace shall display a magnified view of the connector regions, revealing the connector losses (dB). All connector losses shall be measured using the five-point splice loss measurement technique.

3. The OTDR trace shall also include the following information:

   a. The date and time of the test.

   b. The cable ID number.

   c. The cable segment ID number.

   d. The fiber color or sub-cable number.

   e. Launch point connector number.

   f. The optical wavelength used for the test.

   g. The refractive index setting of the OTDR.

   h. The pulse width setting of the OTDR.

   i. The averaging interval of the test.

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SECTION 13330

CONTROL PANELS AND PANEL MOUNTED EQUIPMENT

PART 1 GENERAL

1.01 SCOPE OF WORK

A. Furnish and install control panels and panel mounted equipment as specified herein and shown on the Drawings.

B. All new panels and panel components shall match existing equipment makes and models wherever possible, so that system additions can be most easily integrated with respect to operation and maintenance training, spare parts inventory, and service contracts. Even when exact matches are not possible, equipment furnished must be fully compatible with the existing system. Color, size, and material of new panels should conform to that of existing panels.

PART 2 PRODUCTS

2.01 CONTROL PANEL GENERAL REQUIREMENTS

A. The dimensions within this Section and on the Contract Drawings are for general reference only. Ensure that final enclosure sizing and panel arrangements accommodate all required equipment for a fully integrated and operational system as specified herein and in the Contract Documents.

B. Each control panel and terminal cabinet shall bear the UL label. The UL label shall apply to the enclosure, the specific equipment supplied with the enclosure, and the installation and wiring of the equipment within and on the enclosure. If required for UL labeling, provide ground fault protective devices, isolation transformers, fuses and any other equipment necessary to achieve compliance with UL 508 requirement. The Drawings do not detail all UL 508 requirements.

C. All panel doors shall have a lock installed in the door handle, or a hasp and staple for padlocking. Locks for all panels provided under this Contract shall be keyed alike.

D. The devices designated for rear-of-panel mounting shall be arranged within the panel according to respective panel drawings and in a manner to allow for ease of maintenance and adjustment. Heat generating devices such as power supplies shall be located at or near the top of the panel.

E. The panels shall be completely fabricated, instruments and devices installed and wired at the System Integrator's facility.

F. All components shall be mounted in a manner that shall permit servicing, adjustment, testing, and removal without disconnecting, moving, or removing any other component. Components mounted on the inside of panels shall be mounted on removable plates and not directly to the enclosure. Mounting shall be rigid and stable unless shock mounting is required otherwise by the manufacturer to protect equipment from vibration. Component mounting shall be oriented in accordance with manufacturer's recommendations. The internal components shall be identified with suitable plastic or metal engraved nametags mounted adjacent to (not on) each component identifying the component in accordance with the drawing, specifications, and PCSS's data.

G. All exterior panel mounted equipment shall be installed with suitable gaskets, faceplates, etc.

required to maintain the NEMA rating of the panel.

H. Nameplates

1. All panels and panel devices shall be supplied with suitable nameplates, which identify the panel and individual devices as required. Unless otherwise indicated, each device nameplate shall include up to three lines with the first line containing the device tag number as shown on the drawings, the second line containing a functional description (e.g., Recirculation Pump No. 1), and the third line containing a functional control description (e.g., Start).

2. Unless escutcheon plates are specified or unless otherwise noted on the Drawings, nameplates shall be 3/32-inch thick, black and white, Lamicoid with engraved inscriptions. The letters shall be Black against a White background unless otherwise noted. Edges of the nameplates shall be beveled and smooth. Nameplates with chipped or rough edges will not be acceptable.

3. Nameplate fasteners and mounting shall be epoxy adhesive or stainless steel screws for cabinet mounted nameplates

4. For every panel, provide a panel nameplate with a minimum of 1" high letters. Provide legend plates or 1-in by 3-in engraved nameplates with 1/4-in lettering for identification of door mounted control devices, pilot lights, and meters.

5. Single lamicoid nameplates with multiple legends shall be used for grouping of devices such as selector switches and pilot lights that relate to one function.

I. Mounting Elevations

1. ISA Recommended Practice RP60.3 shall be used as a guide in layout and arrangement of panels and panel mounted components. Dimensions shall account for all housekeeping pads that panels will sit on once they are installed.

2. Centerline of indicators and controllers shall be located no lower than 48-inches or higher than 66-inches above the floor on a panel face.

3. Centerline of lights, selector switches, and pushbuttons shall be located no lower than 32-inches or higher than 70-inches above the floor on a panel face.

4. Tops of annunciators shall be located no higher than 86-inches above the floor on a panel face.

5. Installation of panel components shall conform to component manufacturers' guidelines.

2.02 PANEL MATERIALS AND CONSTRUCTION

A. Structure and Enclosure

1. Panels shall be of continuous welded-steel or FRP construction as shown on the Panel Schedule. Provide angle stiffeners as required on the back of the panel face to prevent panel deflection under instrument loading or operation. Internally the panels shall be

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supplied with a structural framework for instrument support purposes and panel bracing. The internal framework shall permit panel lifting without racking or distortion. Provide removable lifting rings designed to facilitate simple, safe rigging, and lifting of the control panels during installation.

2. Each panel shall be provided with full height, fully gasketed access doors where shown. Doors shall be provided with a three-point stainless steel latch (except for NEMA 4X panels) and heavy duty stainless steel locking handle. Rear access doors (if included) shall be conveniently arranged and sized such that they extend no further than 24-inches beyond the panel when opened to the 90-degree position. Front and side access doors shall be as shown. Panel access doors shall be provided with full length, continuous, piano type stainless steel hinges with stainless steel pins. Front access doors with mounted instruments or control devices shall be of sufficient width to permit door opening without interference from flush mounted instruments.

3. The panels, including component parts, shall be free from sharp edges and welding flaws. Wiring shall be free from kinks and sharp bends and shall be routed for easy access to other components for maintenance and inspection purposes.

4. The panel shall be suitable for top and bottom conduit entry as required by the Electrical Drawings. For top mounted conduit entry, the panel top shall be provided with nominal one-foot square removable access plates, which may be drilled to accommodate conduit and cable penetrations. All conduit and cable penetrations shall be provided with ground bushings, hubs, gasketed locknuts, and other accessories as required to maintain the NEMA rating of the panel and electrical rating of the conduit system.

5. All panels in indoor, dry, non-corrosive environments shall be NEMA 12 unless otherwise noted. All panels in outdoor, wet, and non-chemically corrosive environments shall be NEMA 4 unless otherwise noted. Panels in chemically corrosive environments shall be NEMA 4X unless otherwise noted. All panels located in a hazardous location shall be rated for the type of hazard (e.g., NEMA 7 for Class 1, Division 1).

B. Freestanding and Floor-Mounted Vertical Panels

1. Freestanding and floor-mounted vertical panels shall meet the NEMA classification as shown on the drawings or specified herein. The panels shall be constructed of 12 gauge sheet steel, suitably braced internally for structural rigidity and strength. All NEMA 4X rated panels shall be constructed of 316 stainless steel, unless FRP is specifically indicated to be provided. Front panels or panels containing instruments shall be not less than 10 gauge stretcher leveled sheet steel, reinforced to prevent warping or distortion.

C. Wall and Unistrut Mounted Panels

1. All wall and Unistrut mounted panels shall meet the NEMA classification as shown on the drawings or specified herein. The panels shall be constructed of not less than USS 14 gauge steel, suitably braced internally for structural rigidity and strength. All NEMA 4X rated wall mounted panels shall be constructed of 316 stainless steel, unless FRP is specifically indicated. FRP panels shall be used in chlorine areas. All FRP panels located in direct sunlight shall be provided with a protective coating and sun shield to prevent discoloration and cracking.

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D. Finish Requirements

1. All sections shall be descaled, degreased, filled, ground and finished. The enclosure when fabricated of steel shall be finished with two rust resistant phosphate prime coats and two coats of enamel, polyurethane, or lacquer finish which shall be applied by either the hot air spray or conventional cold spray methods. Brushed anodized aluminum, stainless steel, and FRP panels will not require a paint finish.

2. The panels shall have edges ground smooth and shall be sandblasted and then cleaned with a solvent. Surface voids shall be filled and ground smooth.

3. Immediately after cleaning, one coat of a rust-inhibiting primer shall be applied inside and outside, followed by an exterior intermediate and top coat of a two-component type epoxy enamel. A final sanding shall be applied to the intermediate exterior coat before top coating.

4. Apply a minimum of two coats of flat white lacquer on the panel interior after priming.

5. Unless otherwise noted, the finish exterior colors shall be ANSI 61 gray with a textured finish.

E. Print storage pockets shall be provided on the inside of each panel. The storage pockets shall be steel, welded on to the door, and finished to match the interior panel color. The storage pocket shall be sufficient to hold all of the prints required to service the equipment, and to accommodate 8.5 inch by 11 inch documents without folding.

F. Where specified on the Panel Schedule, a folding shelf shall be provided on the inside of the door on all free-standing and floor-mounted panels. The shelf shall be suitable for a laptop computer and shall be placed such that an open laptop computer does not interfere with any door-mounted devices. The folded shelf shall not interfere with any internal panel components when the door is closed. The folding shelf shall automatically lock in the horizontal position when raised. The folding shelf shall be approximately 18 inches wide by 12 inches deep and shall have a minimum distributed load rating of 100 pounds. All parts shall be made of heavy gauge steel and shall be painted white or finished to match the interior panel color.

2.03 ENVIRONMENTAL CONTROL

A. All panels shall be provided with louvers, sun shields, heat sinks, forced air ventilation, or air conditioning units as required to prevent temperature buildup inside of panel. The internal temperature of all panels shall be regulated to a range of 45 Deg F to 104 Deg F under all conditions. Under no circumstances shall the panel cooling or heating equipment compromise the NEMA rating of the panel.

B. Except for panels mounted with their backs directly adjacent to a wall, louvers shall be in the rear of the panels, top and bottom, and shall be stamped sheet metal construction.

C. For panels mounted with their backs directly adjacent to a wall, louvers shall be on the sides.

D. Forced air ventilation fans, where used, shall provide a positive internal pressure within the panel, and shall be provided with washable or replaceable filters. Fan motors shall operate on 120-volt, 60-Hz power.

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E. For panels with internal heat that cannot be adequately dissipated with natural convection and heat sinks, or forced air ventilation, an air conditioner shall be provided.

1. Provide custom fabricated sun shields for all outdoor panels in accordance with the following requirements:

2. Sun shields shall be fabricated from minimum 12 gauge Type 316 stainless steel. Units shall be designed, fabricated, installed, and supported to fully cover and shade the top, sides and back of the enclosure, and to partially shade the front panel of the enclosure, from direct exposure to sunlight from sunrise to sunset.

3. Depending on overall size, sun shields may be fabricated in single or multiple segments for attachment to the enclosure support framing or to separate free standing framing around the enclosure.

4. Sun shields shall not be attached directly to the enclosure by drilling holes through, or welding studs to, the enclosure surfaces, and shall be designed and mounted to provide a minimum 3-inch air gap all around the enclosure for air circulation and heat dissipation.

5. The top section of all sun shields shall be sloped at a minimum angle of 5 degrees from horizontal. For wall mounted enclosures, the top section shall slope downward away from the wall and towards the front of the enclosure. For free standing, floor mounted and frame mounted enclosures the top section shall slope downward towards the back side of the enclosure.

6. The front edge of the top section of all sun shields shall incorporate a narrow and more steeply sloped drip shield segment which sheds water away from the front of the enclosure and prevents it from dripping or running directly onto the front panel of the enclosure.

7. All seam welds used in sun shield fabrication shall be continuous and shall be ground smooth.

8. All exposed corners, edges and projections shall be smooth rounded or chamfered to prevent injury.

F. All outdoor enclosures and enclosures located in unheated areas indoors or in areas subject to humidity and moisture shall be provided with an integral heater, fan, and adjustable thermostat to reduce condensation and maintain the minimum internal panel temperature. Mount the unit near the bottom of the enclosure with discharge away from heat-sensitive equipment. Heater shall be Hoffman DAH or equal.

## 2.04 CONTROL PANEL - INTERNAL CONSTRUCTION

A. Internal Electrical Wiring

1. All interconnecting wiring shall be stranded, type MTW, and shall have 600 volt insulation and be rated for not less than 90 degrees Celsius. Wiring for systems operating at voltages in excess of 120 VAC shall be segregated from other panel wiring either in a separate section of a multi-section panel or behind a removable Plexiglas or similar dielectric barrier. Panel layout shall be developed such that technicians shall have

complete access to 120 VAC and lower voltage wiring systems without direct exposure to higher voltages.

2. Power distribution wiring on the line side of fuses or breakers shall be 12 AWG minimum. Control wiring on the secondary side of fuses shall be 16 AWG minimum. Electronic analog circuits shall utilize 18 AWG shielded, twisted pair, cable insulated for not less than 600 volts.

3. Power and low voltage DC wiring systems shall be routed in separate wireways. Crossing of different system wires shall be at right angles. Different system wires routed parallel to each other shall be separated by at least 6-inches. Different wiring systems shall terminate on separate terminal blocks. Wiring troughs shall not be filled to more than 60 percent visible fill.

4. Terminations

   a. All wiring shall terminate onto single tier terminal blocks, where each terminal is uniquely and sequentially numbered. Direct wiring between field equipment and panel components is not acceptable.

   b. Multi-level terminal blocks or strips are not acceptable.

   c. Terminal blocks shall be arranged in vertical rows and separated into groups (power, AC control, DC signal). Each group of terminal blocks shall have a minimum of 25 percent spares.

   d. Terminal blocks shall be the compression type, fused, unfused, or switched as shown on the Contract Drawings or specified elsewhere in Division 13.

   e. Discrete inputs and outputs (DI and DO) shall have two terminals per point with adjacent terminal assignments. All active and spare PLC and controller points shall be wired to terminal blocks.

   f. Analog inputs and outputs (AI and AO) shall have three terminals per shielded pair connection with adjacent terminal assignments for each point. The third terminal is for shielded ground connection for cable pairs. Ground the shielded signal cable at the PLC cabinet. All active and spare PLC and controller points shall be wired to terminal blocks.

   g. Wire and tube markers shall be the sleeve type with heat impressed letters and numbers.

   h. Only one side of a terminal block row shall be used for internal wiring. The field wiring side of the terminal shall not be within 6-inches of the side panel or adjacent terminal or within 8-inches of the bottom of free standing panels, or within 3-inches of stanchion mounted panels, or 3-inches of adjacent wireway.

   i. Circuit power from the SCADA cabinet out to field devices (switches, dry contacts etc.) that are used as discrete inputs to the PLC input cards shall be isolated with an isolating switch terminal block with flip cover that is supplied with a dummy fuse. Isolation switch block shall be an Allen Bradley Model 1492-H7 or equal. One

isolating switch terminal block per loop numbered piece of equipment and one per spare I/O point is acceptable.

j. All PLC discrete outputs to the field shall be isolated with an isolating fuse switch terminal block with a flip cover and a neon blown fuse indicator. The single circuit fusible terminal block shall be an Allen Bradley 1492-H4 or equal.

5. All wiring to hand switches and other devices, which are live circuits independent of the panel's normal circuit breaker protection, shall be clearly identified as such.

6. All wiring shall be clearly tagged and color coded. All tag numbers and color coding shall correspond to the panel wiring diagrams and loop drawings prepared by the PCSS. All power wiring, control wiring, grounding, and DC wiring shall utilize different color insulation for each wiring system used. The color coding scheme shall be:

   a. Incoming 120 VAC Hot - Black

   b. 120 VAC Hot wiring downstream of panel circuit breaker – Red

   c. 120 VAC Hot wiring derived from a UPS system – Red with Black stripe

   d. Three phase power – Brown, Orange, Yellow, and Green ground or as specified in Division 16.

   e. 120 VAC neutral - White

   f. Ground - Green

   g. DC power or control wiring – Blue

   h. DC analog signal wiring – Black (+), White (-)

   i. Foreign voltage – Yellow

7. Provide surge protectors on all incoming power supply lines at each panel per the requirements of Section 13300.

8. Each field instrument furnished under Division 13 and shown on the Drawings as deriving input power from the control panel(s) shall have a separate power distribution circuit with a circuit breaker or fuse and blown fuse indication. All instruments requiring 120VAC power shall be powered from the UPS source in the panel where the instrument signals lands.

9. Provide redundant 24 VDC power supplies to power field instruments and panel devices. Twenty-four VDC power supplies shall be as specified in this Section.

10. Wiring trough for supporting internal wiring shall be plastic type with snap-on covers. The side walls shall be open top type to permit wire changing without disconnecting. Trough shall be supported to the subpanel by stainless steel screws. Trough shall not be bonded to the panel with glue or adhesives.

11. Each panel shall have a single tube, fluorescent light fixture, 20 Watt in size, mounted

internally to the ceiling of the panel. Light fixture shall be switched and shall be complete with the lamp.

12. Each panel shall have a specification grade duplex convenience receptacle with ground fault interrupter, mounted internally within a stamped steel device box with appropriate cover. Convenience receptacle shall not be powered from a UPS and shall be protected by a dedicated fuse or circuit breaker.

13. Each panel shall be provided with an isolated copper grounding bus for all signal and shield ground connections. Shield grounding shall be in accordance with the instrumentation manufacturer's recommendations.

14. Each panel shall be provided with a separate copper power grounding bus (safety) in accordance with the requirements of the National Electrical Code.

15. Each panel shall have control, signal, and communication line surge suppression in accordance with Section 13300.

16. All microprocessor-based electronic devices in the panel that are powered by 120VAC shall be powered by the UPS.

17. Each panel shall be provided with a circuit breaker to interrupt incoming power. Provide a minimum of two (2) spare 20-amp breakers.

18. Additional electrical components including transformers, motor starters, switches, circuit breakers, etc. shall be in compliance with the requirements of Division 16.

2.05 ELECTRICAL COMPONENTS

A. The main circuit breaker shall be a thermal-magnetic molded case breaker, by Square D Company, or equal. Provide a flange mounted main power disconnect operating handle with mechanical interlock having a bypass that will allow the panel door to open only when the switch is in the OFF position.

B. A mechanical disconnect mechanism, with bypass, shall be installed on each motor circuit protector, capable of being locked in the "OFF" position to provide a means of disconnecting power to the motor.

C. Auxiliary contacts shall be provided for remote run indication and indication of each status and alarm condition. Additional controls shall be provided as specified herein and as required by the detailed mechanical equipment requirements, the P&IDs (Division 13), the Control Wiring Diagrams (Division 16) and as shown on the Drawings.

D. All operating control devices and instruments shall be securely mounted on the exterior door. All controls shall be clearly labeled to indicate function and shall be in accordance with the electrical area classification indicated on the Electrical Contract Drawings.

E. A six digit, non-resettable quartz time base elapsed time meter shall be connected to each motor starter. Meter shall be Hobbs 98000 Series, Redington Model 722, Cramer Model ETI-635 G, or equal.

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F. The control panel shall be provided with a lightning and surge protection unit on the line side of the main circuit breaker. Unit shall be 600 Volt, 3 Phase, General Electric "Tranquell" Series, or equal.

G. Where required by Specifications, an alternator shall be provided to sequence motors. Alternator shall be Catalog No. 008-120-13SP or 009-120-23AP by Stacon; Square D, Class 9039, Type HG-21 or equal.

H. Panel mounted timers shall be flush mounted, plug-in type, Eagle Signal Bulletin 125 cycle-flex, Idec SR6P-MO8G or equal, with ranges as shown on the Drawings, or as required by the detailed mechanical equipment specifications.

I. Specific control devices, control descriptions and other data are specified under the detailed specification for the mechanical equipment with which the control panel is supplied.

2.06 Pilot Type Indicating Lights

2.07 Type: Energy efficient Solid State LED Lamps.

2.08 Functional:

A. Units shall be provided with low voltage LED lamps suitable for the voltage supplied.

B. Lights supplied with 120V AC power shall have integral reduced voltage transformers.

C. Lamps shall be replaceable from the front of the unit.

D. Physical:

1. Lens color:

a. Running, on, open – Red.

b. Stopped, off, closed – Green.

c. Alarm – Amber.

d. White - Power on

e. Blue - All other status indications not covered by the above

2. Lens caps shall be approximately .46 inch diameter. Provide legend faceplates engraved to indicate the required function of each device; NEMA rating - 4X.

E. Manufacturer(s):

1. Cutler-Hammer.

2. Allen Bradley.

3. General Electric.

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4. Square D.

5. Crouse Hinds (NEMA 7).

6. Equal.

2.09 Selector Switches and Pushbuttons

A. Type:

1. Control devices shall be heavy-duty oil tight type with stackable contact blocks.

B. Functional:

1. Provide contact arrangement and switching action as required for the control system specified.

C. Physical:

1. For 120 VAC service provide contacts rated 10 amps at 120 VAC, for 24 VDC service provide silver sliding contacts rated 5 amps at 125 VDC, for electronic (millivolt/ milliamp) switching provide contacts rated lamp at 28 VDC.

2. Pushbuttons shall have flush type operators.

3. Selector switches shall have knob or wing lever operators; NEMA rating - 4X; Provide legend plates denoting switch/pushbutton position/ function.

D. Manufacturer(s):

1. Cutler-Hammer.

2. Allen Bradley.

3. General Electric.

4. Square D.

5. Crouse Hinds (NEMA 7).

6. Equal.

2.10 Potentiometer

A. Type:

1. Device shall be heavy-duty 30 mm oil tight type.

B. Functional:

1. 270 degree dial

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2. Rated for 1,000 ohms.

C. Physical:

1. Mounting: Suitable for panel mounting

2. NEMA 4X rating; escutcheon plates scaled in engineering units.

D. Manufacturer(s):

1. Allen Bradley Co.

2. Cutler-Hammer.

3. Square D.

4. Equal.

## 2.11 GENERAL PURPOSE RELAYS AND TIME DELAYS

A. Type:

1. General purpose plug-in type.

B. Functional:

1. Contact arrangement/function shall be as required to meet the specified control function; Mechanical life expectancy shall be in excess of 10 million.

2. Duty cycle shall be rated for continuous operation; Units shall be provided with integral indicating light to indicate if relay is energized.

3. Solid state time delays shall be provided with polarity protection (DC units) and transient protection.

4. Time delay units shall be adjustable and available in ranges from .1 second to 4.5 hours.

C. Physical:

1. For 120 VAC service provide contacts rated 10 amps at 120 VAC, for 24 VDC service provide contacts rated 5 amps at 28 VDC, for electronic (milliamp/millivolt) switching applicator provide gold plated contacts rated for electronic service; relays shall be provided with dust and moisture resistant covers.

D. Options/Accessories Required:

1. Provide mounting sockets with pressure type terminal blocks rated 300 volt and 10 amps.

2. Provide mounting rails/holders as required.

E. Manufacturer(s):

1. IDEC.
2. Allen Bradley.
3. Potter & Brumfield.
4. Equal.

2.12 SIGNAL ISOLATORS/BOOSTERS/CONVERTERS

A. Type:

1. Solid state, ASIC technology; electronic type.

B. Functional:

1. Accuracy: 0.15 percent.
2. Inputs: Current, voltage, frequency, temperature, or resistance as required.
3. Outputs: Current or voltage as required.
4. Isolation: There shall be complete isolation between input circuitry, output circuitry, and the power supply.
5. Adjustments: Zero and span adjustment shall be provided.
6. Protection: Provide RFI protection.

C. Physical:

1. Mounting: DIN Rail.

D. Manufacturer(s):

1. Action Instruments Slim Pak.
2. Acromag.
3. Equal.

2.13 INTRINSICALLY SAFE RELAYS

A. Type:

1. Relays shall be of the solid state electronic type in which the energy level of the sensing or actuation circuit is low enough to allow safe usage in hazardous areas.

B. Options Required:

1. Relays shall match power supply provided.

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2. Relays shall be located in non-hazardous areas.

C. Manufacturer(s):

1. Consolidated Electric.
2. Gems Safe-Pak.
3. Warrick Controls.
4. R. Stahl, Inc.
5. Equal.

## 2.14 INTRINSIC SAFETY BARRIERS (FOR 2-WIRE TRANSMITTER SYSTEMS)

A. Intrinsic safety barriers shall be passive devices requiring no external voltage supply and supplied with series resistors, series fuse and shunt zener diodes to limit the transfer of energy to levels required by intrinsically safe protection between safe and hazardous locations.

B. Unit shall be Factory Mutual approved and certified for use in accordance with National Fire Protection Association (NFPA 493).

C. Manufacturer(s):

1. P&F.
2. Gems.
3. Unitech.
4. Equal.

## 2.15 24 VDC POWER SUPPLIES

A. Provide a 24 VDC power supply in the control panel to power field instruments, panel devices, etc., as required. Equip the power supply with a power on/off circuit breaker.

B. The 24 VDC power supply shall meet the following requirements:

1. Input power: 115 VAC, plus or minus 10 percent, 60 Hz.
2. Output voltage: 24 VDC.
3. Output voltage adjustment: 5 percent.
4. Line regulation: 0.05 percent for 10 volt line change.
5. Load regulation: 0.15 percent no load to full load.
6. Ripple: 3 mV RMS.

7. Operating temperature: 32 to 140 degrees Fahrenheit.

C. Size the 24 VDC power supply to accommodate the design load plus a minimum 25 percent spare capacity.

D. If power supply on/off status signal is shown, provide a relay contact (internal to the power supply or external if the power supply is not so equipped) to indicate on/off status of the power supply.

E. Provide output overvoltage and overcurrent protective devices with the power supply to protect instruments from damage due to power supply failure and to protect the power supply from damage due to external failure.

F. Mount the 24 VDC power supply such that dissipated heat does not adversely affect other panel components.

G. Manufacturer(s):

1. Acopian.

2. PULS.

3. Lambda.

4. Equal.

2.16 DIGITAL PANEL METER

A. Type:

1. Electronic, 3.5 digit, 0.56 inch high efficiency LED display.

B. Operation:

1. To accept 4-20 mA DC input signal and provide indication in Engineering Units of measured variable.

C. Functional:

1. Power supply: 115 VAC, plus or minus 10 percent, 50/60 Hz, 10 VA.

2. Input: 4-20 mA DC into 100 ohms.

3. Indication: 0.56 inch LED display.

D. Physical:

1. Case size nominal 2.5 inch high by 5 inch wide by 6 inch deep.

2. Case type: watertight and dust-tight (NEMA 4X).

3. Mounting: flush panel suitable for high density mounting arrangements.

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E. Performance: Linear input accuracy plus or minus 0.05 percent of calibrated span, plus or minus 1 count.

F. Manufacturer(s):

1. Precision Digital.

2. Red Lion.

3. Equal.

## PART 3 EXECUTION

### 3.01 INSTALLATION

A. The panels shall be installed at locations as shown on the Contract Drawings.

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SECTION 13340

INSTRUMENTATION AND CONTROLS – ANALYTICAL DEVICE

PART 1 GENERAL

1.1 SCOPE OF WORK

A. This section covers the furnishing, installation, and services for the field-mounted analyzers as detailed on the Drawings.

1.2 MAINTENANCE

B. Accessories

1. All mounting hardware required for pipe stand, surface, or other mounting shall be provided.

2. Each instrument shall be provided with a manufacturer installed stainless steel tag identifying the instrument tag number.

PART 2 PRODUCTS

2.1 DISSOLVED OXYGEN ANALYZER (LUMINESCENT-TYPE SENSOR)

A. Electrode Cartridge/Sensor Assembly

1. Type: Continuous monitoring of dissolved oxygen using a luminescent membrane excited with blue light pulses.

2. Function/Performance:

a. Accuracy: plus or minus 0.1 ppm (DO<1 ppm); plus or minus 0.2 ppm.

b. Repeatability: 0.005 ppm.

c. Measuring Range: 0 to 20 ppm.

d. Sensitivity: plus or minus 0.05 percent of span.

e. Measuring Range: 0 to 50 degrees C.

f. Materials on Construction: Probe, noryl and 316SS; sensor, polybutyl methacrolate.

g. Warranties: Probe, 3 years; Sensor, 1 year.

3. Accessories Required:

a. One spare sensor cap for each set of ten or less sensor assemblies provided.

b. Sufficient cable for installation between the sensor and analyzer/controller as indicated on the Drawings.

c. One mounting bracket per sensor for fixing the sensor assembly to hand railing or other fixed support.

2. Manufacturer(s):

a. Hach LDO sensor assembly.

b. Equal.

B. Analyzer/Controller

1. Type: Microprocessor-based controller compatible with sensor furnished.

2. Function/Performance:

a. Accuracy: plus or minus 0.1 percent of span.

b. Repeatability: plus or minus 0.05 percent of span.

c. Response Time: 60 seconds to 90 percent of value on step change.

d. Temperature Range: -40 to 60 degrees C.

e. Output: Two 4-20 mA outputs and three programmable Form C alarm contact outputs rated for 5A at 230 VAC.

f. Temperature Compensation: Compensation over the temperature range of the instrument.

g. Diagnostics: On screen instructions and display of self diagnostics.

h. Display: Digital indicator displaying concentration in ppm and temperature of the medium.

3. Physical:

a. Converter shall be suitable for surface or pipe stand mounting.

b. Enclosure shall be NEMA 4X (IP67).

c. Power requirements: 120 VAC/60 Hz.

4. Manufacturer(s):

a. Hach sc100 Controller.

b. Equal.

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2.2 CHLORINE RESIDUAL ANALYZER

A. Type:

1. Microprocessor based electronic transmitter/converter a flow through sample cell.

2. Measures free or total chlorine. Analyzer to be configured or specified for free or total chlorine as indicated on the Drawings or the Instrument Device Schedule.

3. Utilizes amperometric methods.

B. Function/Performance:

1. Accuracy: plus or minus 1 percent of full scale or 0.002 mg/l, whichever is greater, below 20 mg/l; plus or minus 5 percent of reading between 20 and 50 mg/l.

2. Resolution: 0.001 mg/l (<10 mg/l) and 0.01 mg/l (10 to 20 mg/l).

3. Range: 0-50 mg/l.

4. Environmental Conditions: The instrument shall operate over an ambient temperature range of 2-50 degrees C.

5. Output: Isolated 4-20 mA output and 3 programmable alarm contacts rated for 5A at 230 VAC.

6. Display: Dot matrix or LCD type displaying chlorine residual in ppm.

7. Temperature Compensation: Compensated for sample temperatures over the temperature range of the instrument.

8. Diagnostics: On screen instructions and self diagnostics.

9. Response: 90 percent of full scale within 2 minutes.

10. Physical:

a. Analyzers shall be suitable for surface mounting.

11. Power Requirements: 120 VAC/60 Hz.

12. Electronics enclosure shall be NEMA 4X.

13. Sensor shall have three electrodes and shall have an automatic cleaning mechanism.

14. Accessories Required:

a. Provide one year's supply of consumables and one spare electrode.

15. Manufacturer(s):

a. Capital Controls Series CL1000.

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b. Wallace & Tiernan Micro 2000.

c. Equal.

2.3 PH ANALYZER

A. Sensor

1. Type:

a. pH-sensitive glass membrane electrode, double or triple-junction reference electrode and ground electrode with integral preamplifier.

b. For submersion or flow-through application as indicated on the Drawings or in the Instrument Device Schedule.

2. Function/Performance:

a. Range: 0 to 14.

b. Temperature Compensation: Temperature element integral to sensor for temperature compensation.

3. Physical:

a. Flat glass or shrouded pH electrode.

b. Sensor assembly constructed of PVDF, Tefzel, or similar material.

c. Sealed electrodes.

4. Accessories Required:

a. Manufacturer's cable for connection of sensor to transmitter. Length as required by installation indicated on drawings.

b. One year's supply of consumables for calibration.

c. Handrail mounting kit where indicated on the Drawings to be required.

5. Manufacturer(s):

a. GLI PD Series.

b. Rosemount Model 389.

c. Foxboro 871A.

d. Equal.

B. Transmitter

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1. Type:
   a. Microprocessor-based, intelligent transmitter compatible with sensor provided.
2. Function/Performance
   a. Accuracy (including sensor): plus or minus 0.05 pH.
   b. Repeatability (including sensor): plus or minus 0.01 pH.
   c. Range: 0 to 14.
   d. Environmental conditions: 0 to 55 degrees C and 5 to 95 relative humidity.
   e. Output: One 4-20 mA output adjustable over the range of 0 to 14. Two alarm contacts rated for 5A at 230 VAC, configurable over the output range.
   f. Temperature Compensation: Compensation over a temperature range of 0 to 85 degrees C.
   g. Diagnostics: On screen instructions and display of self diagnostics.
   h. Display: Digital indicator displaying pH.
3. Physical:
   a. Transmitter shall be suitable for surface or pipe stand mounting.
   b. Enclosure shall be NEMA 4X (IP65).
   c. Power requirements: 120 VAC/60 Hz.
4. Manufacturer(s):
   a. GLI P53.
   b. Rosemount Model 1055 pH.
   c. Foxboro 873.
   d. Equal.

PART 3 EXECUTION: NOT USED

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SECTION 13341

INSTRUMENTATION AND CONTROLS – FLOW DEVICES

PART 1 GENERAL

1.1 SCOPE OF WORK

A. This section covers the furnishing, installation, and services for the field-mounted instruments as detailed on the Drawings.

B. Accessories:

1. All mounting hardware required for pipe stand, surface, or other mounting shall be provided.

2. Each instrument shall be provided with a manufacturer installed stainless steel tag identifying the instrument tag number.

PART 2 PRODUCTS

2.1 MAGNETIC FLOWMETER

A. Flow Element

1. Type:

a. Pulsed DC type.

2. Function/Performance:

a. Operating Temperature: Process liquid temperatures of minus 10 to 70 degrees C and an ambient of minus 10 to 60 degrees C.

b. Radio Frequency Interference (RFI) protection: RFI protection shall be provided as recommended by the manufacturer.

c. Pressure rating: Equal to piping system where meter is installed.

d. Additional: Meter shall be capable of running empty indefinitely without damage to any component.

3. Physical:

a. Metering Tube: 304 stainless steel or equivalent.

b. Flanges: ANSI 150 lb. or DIN PN 16 carbon steel, as required by the piping system, unless otherwise indicated.

c. Liner: Polyurethane unless otherwise indicated on the Drawings or in the

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Instrument Device Schedule.

d. Electrodes: 316 stainless steel, bullet nosed or elliptical self-cleaning type unless otherwise noted.

e. Housing: Meters below grade shall be suitable for submergence for up to 48 hours to a depth of 30 ft (9m). Meters above grade shall be NEMA 4X (IP65). Where hazardous areas are indicated on the Drawings, the equipment shall be rated for that area.

f. Finish: All external surfaces shall have a chemical and corrosion resistant finish.

4. Accessories/Documentation Required:

a. Factory calibration: All meters shall be factory calibrated. A copy of the report shall be included in the O&M manual.

b. Grounding: Meter shall be grounded in accordance with the manufacturer's recommendation. Provide ground ring, ground wires, gaskets, etc., as required. All materials shall be suitable for the liquid being measured.

c. Electrode cleaning unit: Where indicated in the Instrument Device Schedule, provide an electrode cleaning system. The system generator/controller shall be housed in a NEMA 4X wall mounted enclosure. Provide all necessary cables and connectors. The generator shall be powered through manufacturer supplied cables for the magnetic flowmeter or from the A/C supply to the transmitter.

d. Signal cable for installation between the flowtube and the transmitter. Length shall be as required by installation indicated on the Drawings.

5. Manufacturer(s):

a. ABB Instruments MagMaster.

b. Krohne OPTIFLUX 2000.

c. Siemens SITRANS FM MAGFLO.

d. Rosemount Series 8700.

e. or equal

B. Flow Converter/Transmitter

1. Type:

a. Micro processor based, intelligent transmitter compatible with flowtube provided.

b. Mounted remote from the flowtube.

2. Functional/Performance:

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a. Accuracy (including flowtube): Plus/minus 0.5 percent of flowrate.

b. Operating Temperature: –10 to 50 degrees C.

c. Output: Isolated 4-20 mA with HART protocol. Current output adjustable over the full range of the instrument.

d. Diagnostics: Self diagnostics with on screen display of faults.

e. Display: Digital indicator displaying flow in engineering units indicated in the Instrument Device Schedule.

f. Totalizer: A fully configurable totalizer integral to the transmitter. Totalized flow shall be displayed.

g. Empty Tube Zero: The transmitter shall include a feature that will lock the output at zero when no flow is detected. The empty tube zero feature shall be enabled automatically when the transmitter detects no flow or manually through a contact input.

3. Physical:

a. Transmitter shall be suitable for surface or pipe stand mounting.

b. Enclosure shall be NEMA 4X (IP65).

c. A/C power will be as specified in Section 13300.

4. Accessories/ Required:

a. Keypad where required for transmitter configuration.

5. Manufacturer(s):

a. ABB Instruments MagMaster Transmitter.

b. Krohne Autoflux IFC 090.

c. Siemens MAGFLO MAG 5000/6000.

d. Rosemount Series 8712.

## 2.2 ULTRASONIC OPEN CHANNEL FLOW METER

A. Sensor

1. Type:

a. Non-contact, ultrasonic level transducer.

2. Function/Performance:

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a. Measuring Range: Sensor range shall be suitable for the installation indicated on the Drawings.

b. Operating Temperature: –30 to 70 degrees C.

c. Relative humidity: 0 to 100 percent.

d. Temperature Compensation: Sensors shall be provided with integral temperature sensors for temperature compensation.

3. Physical:

a. Sensors shall be potted/encapsulated in a Kynar, or other chemical and corrosion resistant housing. Where the Drawings indicate sensors are to be installed in hazardous areas, they shall be approved for installation in Class I, Division 1, Groups C and D (Zone 0) environments.

b. Sensors shall be capable of being completely submersed without damage.

c. Sensors shall be suitable for surface, pipe, or flange mounting as indicated on the Drawings or in the Instrument Device Schedule.

4. Accessories Required:

a. The supplier shall be responsible for coordinating all sensor mounting requirements and shall furnish dimensional and elevation drawings to ensure a proper and satisfactory installation.

b. Sensors located in areas where freezing condensation may occur shall be provided with special heaters or other types of transducer protection designed to prevent sensor icing.

c. Signal cable as recommended by the manufacturer, for installation between the sensor and the transmitter. Length up to 1000 ft (300 m) shall be as required by the installation indicated on the Drawings.

5. Manufacturer(s):

a. Siemens OCM III or HydroRanger 200

b. Equal.

B. Transmitter/Converter

1. Type:

a. Microprocessor based transmitter.

2. Functional/Performance:

a. Resolution (including sensor): Plus or minus 0.1 percent of range or 0.08 inches (2 mm), whichever is greater.

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b. Accuracy (including sensor): Plus or minus 0.25 percent of range or 0.24 inches (6 mm).

c. Range: 0 to 10 feet (0 to 3.1 m).

d. Temperature Range: 0 to 50 degrees C.

e. Output: One isolated 4-20 mA output and four alarm contacts adjustable to trip at any point in the instrument range. Output contacts shall be rated 0.5 A at 120 VAC.

f. Temperature Compensation: Compensation over the temperature range of the sensor.

g. Display: Digital indicator displaying flow in engineering units indicated in on the Drawings or in the Instrument Device Schedule.

h. Totalizer: A fully configurable totalizer integral to the transmitter. Totalized flow shall be displayed.

i. Diagnostics: On screen instructions and display of self diagnostics.

j. Loss of Signal: Transmitter shall ignore momentary loss-of-echo and shall indicate sustained loss of echo on the transmitter unit.

k. Flume Curve: The transmitter shall include a facility for entering points on a flume curve for characterization of the instrument output.

l. Configuration Protection: Programmable parameters shall be protected using E2PROM. Battery backup protection is not acceptable.

3. Physical:

a. Transmitter shall be suitable for surface or pipe stand mounting.

b. Enclosure shall be NEMA 4X (IP65).

c. A/C p.

4. Accessories Required:

a. Handheld programmer where required, for configuration or calibration of the instrument.

5. Manufacturer(s):

a. Siemens Model HydroRanger 200

b. Equal.

PART 3 EXECUTION: NOT USED

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END OF SECTION

# DIVISION 15

# MECHANICAL

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SECTION 15051

# PIPE TESTING - GENERAL REQUIREMENTS

## PART 1 GENERAL

### 1.01 SCOPE OF WORK

A. This Section specifies the general requirements for testing the various piping systems shown on the Drawings and as specified herein. Refer to Piping and System Section specs for actual test parameters.

### 1.02 RELATED WORK

A. Pipe, joints, piping systems and appurtenances are specified in other Sections of Division 15.

### 1.03 SUBMITTALS

A. Test Records

1. Records shall be maintained of all tests performed.

2. Test records shall include:

   a. Date of Testing

   b. Identification of Piping Tested

   c. Test Fluid

   d. Test Pressure

   e. Signatures of Contractor and Engineer

3. If leaks are found, they shall be noted, on the record. After correction, retesting as specified for original test.

4. Records of test shall be maintained by the Contractor and 4 copies furnished to the Engineer.

### 1.04 REFERENCE STANDARDS

A. American National Standards Institute (ANSI)

1. ANSI B31 - Code for Pressure Piping, B31 Interpretation.

B. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

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PART 2 PRODUCTS

2.01 TEST FLUIDS

A. Hydrostatic Test - Water should be used as the test fluid whenever possible. In those systems where water cannot be used the test fluid may be either the one to be used in the system or the one agreed upon by the Engineer and the Contractor.

B. Service Pressure Test - The fluid for which the system is designed shall be the test fluid.

C. Pneumatic Test - Compressed air shall normally be used. Other gases may be used when specified or directed by the Engineer. Test pressures shall be 110 percent of the anticipated maximum operating pressure, but not exceeding 100 psig, and not less than 5 psig at the highest point in the system.

2.02 TEST EQUIPMENT

A. Hydrostatic Test

1. Water - Of sufficient capacity to deliver the required test pressure.

2. Strainer - On inlet side of the pump to prevent foreign matter from entering the system.

3. Valves - Shall be provided on the suction and discharge side of the pump.

4. Heater - To allow heating of the test fluid when elevated temperatures are required for test.

5. Relief Valve - Set at a pressure to relieve at 20 to 25 percent above the required test pressure.

6. Pressure Gauge(s) - Capable of reaching 50 percent over the test pressure. These should be located at the pump discharge and any other place deemed convenient by the Contractor.

7. Pressure gauges and relief valves shall be checked for accuracy before use in test procedures.

B. Service Pressure Test

1. A pressure gauge capable of registering 25 psi over the design pressure shall be installed down-stream from the supply shut-off valve if one is not included in the system.

C. Pneumatic Test.

1. Building supply air to deliver the required test pressure if available, or provide a compressor capable of the required test pressure.

2. Valves shall be provided on the discharge side of the pump.

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3. Relief valve to relieve at 10 to 15 percent over the test pressure.

4. Pressure gauge(s) capable of reaching 50 percent over the test pressure. A gauge shall be located on the pump discharge and other location as required.

## PART 3 EXECUTION

### 3.01 HYDROSTATIC TEST

A. This test shall be used to hydrostatically test piping systems for structural integrity and leaks. The test shall be performed at ambient temperature unless otherwise specified.

B. Preparation for Test

1. Determine the fluid to be used for the test, and, if other than ambient temperature is required, what the test temperature will be.

2. When a fluid other than water is used for a test, the equipment used for the test shall be of a material compatible with the test fluid. Normally this would be equal to the piping material.

3. Vents shall be provided at the high points of the system and drains provided where means of venting or draining do not exist.

4. Remove or block off, all relief valves, rupture discs, alarms, control instruments, etc, that shall not be subjected to the test pressure.

5. All discs, balls, or pistons from check valves shall be removed if they interfere with filling of the system. Open all valves between inlet and outlet of the section to be tested.

6. Connect pump and provide temporary closures for all of the external openings in the system. Use caution to insure that the closures are properly designed and strong enough to withstand the test pressure.

7. All joints, including welds, are to be left uninsulated and exposed for examination during test.

8. A joint previously tested in accordance with this specification may be covered or insulated.

9. Piping designed for vapor or gas shall be provided with additional temporary supports, if necessary, to support the weight of the test liquid.

10. Expansion joints shall be provided with temporary restraint for additional pressure under test or shall be isolated from the test.

11. Flanged joints, where blanks are inserted to isolate equipment during the test, need not be tested.

C. The hydrostatic test pressure shall be 1-1/2 times the design pressure unless otherwise specified in the System Section.

D. Test Procedures

1. Allow the test fluid to enter the system. Open vents to allow displacement of all entrapped air. For all pipelines exceeding 500-ft in length, the maximum rate of filling shall be limited to that which produces a maximum nominal flow velocity of one foot per second in the pipe to be tested.

2. Close vents and restrict personnel in the test area to those involved in the test.

3. Raise the pressure slowly with the pump until the predetermined test pressure is reached. Maintain pressure for duration of time specified in System Section, keeping personnel at a safe distance.

4. Reduce the pressure about 20 percent and hold it at that point while the entire system is carefully inspected for leaks, cracks, or other signs of defects.

5. If defects are found, the pressure shall be released, the system drained, the defects corrected and the test repeated.

6. After a satisfactory test has been completed, the line shall be drained.

E. Flushing

1. Lines tested with water shall be completely drained.

2. Lines shall be flushed, after test.

3.02 SERVICE PRESSURE TEST

A. This test shall be used to test piping systems using service pressure and the fluid for which the system is used. It shall not be used to test piping systems conveying combustible or flammable liquids or systems that comply with ANSI B31 codes. Insulated lines shall have all joints left exposed until completion of the test.

B. The test pressure shall be equal to the maximum pressure that the line will be subjected to under normal operating conditions as determined by the Engineer.

C. Test Procedures

1. Liquids

a. See that all personnel not involved in the test vacate the area.

b. Allow the system fluid to enter the system slowly while venting the air at the extreme far and uppermost points. For all pipelines exceeding 500-ft in length, the maximum rate of filling shall be limited to that which produces a maximum nominal flow velocity of one foot per second in the pipe to be tested.

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c. When the system is full and all air is vented, close the vents.

d. Allow the pressure in the system to build up to the full line pressure.

e. Inspect entire system for leaks.

2. Gas or Vapor (Including Compressed Air and Steam)

a. See that all personnel not involved in the test vacate the area.

b. In systems that do not have a pressure gauge near the main shut-off valve, a gauge shall be installed.

c. Allow the system fluid to enter the system slowly until the full operating pressure is reached.

d. Shut off main supply valve. Observe the gauge for 15 minutes. The pressure gauge shall not drop during this time.

e. If the gauge drops, indicating the presence of leaks, the systems shall be inspected visually and, if necessary, with soap suds or commercially available leak detectors to locate the leak(s).

3. If leaks are found, the lines shall be relieved of pressure, purged if necessary and repaired. Tests shall be repeated for repaired sections.

3.03 PNEUMATIC TEST

A. This procedure for a pneumatic test of piping systems shall be used when directed by the Engineer when water, or other liquid, cannot be introduced into the line, or as a supplement to a hydrostatic test.

B. Safety

1. All pneumatic tests shall be done under the supervision of Contractor and in the presence of the Engineer.

2. New Construction: The Engineer's permission shall be secured before testing.

3. Renovation Projects: The Owner representative and the Engineer must be informed and their permission secured before testing.

4. Only those people actively participating in the test shall be allowed in the test area.

5. Safety glasses and hard-hats must be worn.

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C. Test Procedures

1. Increase the pressure in the line gradually, in steps, to the specified pressure. Checks shall be made at 25 psig until the test pressure is reached using sound, soap solution or a drop in indicated pressure.

2. When the specified pressure for the test is reached, shut off the valve in the supply line from the pump.

3. Maintain the test pressure long enough to visually inspect all joints or a minimum of 10 minutes. There shall be no drop in the test pressure in this time.

4. Leaks shall be repaired and the line retested. All leaks shall be noted on the Test Record form.

5. After satisfactory completion of the test, vent the line and allow it to return to atmospheric pressure. Connection can then be made to the supply line.

END OF SECTION

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SECTION 15061

STEEL PIPE AND FITTINGS

PART 1 GENERAL

1.01 SCOPE OF WORK

A. Furnish all labor, materials, equipment and incidentals required and install all non-buried steel pipe and appurtenances as shown on the Drawings and as specified herein.

B. Steel pipe shall include black steel and galvanized steel pipe and fittings.

1.02 RELATED WORK

A. Buried pipe is included in Division 2.

B. Field painting, except as specified herein, is included in Section 09902.

C. Stainless steel pipe and fittings are included in Section 15066.

D. Valves and appurtenances are included in Section 15100.

E. Pipe hangers and supports are included in Section 15140.

1.03 SUBMITTALS

A. Submit, in accordance with Section 01300, a list of materials to be furnished, the names of the suppliers and the date of delivery of materials to the site. Submittals shall include the following:

1. Shop drawings including piping layouts, schedules, dimensioning, fittings, locations of valves and appurtenances, joint details, methods and locations of supports and all other pertinent technical specifications for all piping to be furnished.

2. Shop drawing submittals for piping under this Section shall include all data and information required for the complete piping systems. All dimensions shall be based on the actual equipment to be furnished. Types and locations of pipe hangers and/or supports shall be shown on the piping layouts for each piping submittal.

1.04 REFERENCE STANDARDS

A. American Society for Testing and Materials (ASTM)

1. ASTM A47 - Standard Specification for Ferritic Malleable Iron Castings.

2. ASTM A53 - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.

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3. ASTM A105 - Standard Specification for Carbon Steel Forgings, for Piping Applications.

4. ASTM A153 - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.

5. ASTM A234 - Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service.

6. ASTM A307 - Standard Specification for Carbon Steel Bolts and Studs 60,000 psi Tensile Strength.

7. ASTM A714 - Standard Specification for High-Strength Low-Alloy Welded and Seamless Steel Pipe.

B. American National Standards Institute (ANSI)

1. ANSI B16.1 - Cast Iron Pipe Flanges and Flanged Fittings

2. ANSI B16.5 - Pipe Flanges and Flanged Fittings

3. ANSI B16.9 - Factory-Made Wrought Steel Buttwelding Fittings

C. American Welding Society (AWS)

D. American Water Works Association (AWWA)

E. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.05 QUALITY ASSURANCE

A. All steel pipe and fittings shall be furnished by manufacturers who are fully experienced, reputable and qualified in the manufacture of the items to be furnished. The equipment shall be designed, constructed and installed in accordance with the best practices and methods and shall comply with this Section as applicable.

B. Steel pipe and fittings shall conform to all applicable standards of ASTM, ANSI and AWWA.

1.06 SYSTEM DESCRIPTION

A. Steel piping shall be installed in the locations shown on the Drawings.

B. The equipment and materials specified herein are intended to be standard types of steel pipe and fittings for use in transporting air.

C. Steel piping system listed below shall be designed for the following conditions:

System: Low Pressure Air

Material: Copper nickel steel ASTM A714

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Air Pressure:
Normal: 10 psi
Test: 15 psi

Flow Velocity: 2000 fpm (maximum)

Temperature: Ambient to 200 degrees F

Special Conditions: Blower vibration

## PART 2 PRODUCTS

### 2.01 MATERIALS

A. Seamless steel pipe shall be standard weight, Schedule 40 and shall conform to ASTM A53. Where indicated on the Drawings to be galvanized, pipe shall be hot-dipped galvanized after fabrication.

B. Joints for pipe 2-in or less shall be threaded for standard screwed joints. Threaded joints shall be made up with good quality thread compound and applied to the male thread only. After having been set up, a joint shall not be backed off unless the joint is completely broken, the threads cleaned and new compound applied. All joints shall be air tight. A sufficient number of unions shall be provided to allow for convenient removal of piping.

C. Fittings for steel pipe 2-in or less shall be standard malleable iron, 150 lbs except for steam and hot water cleaning piping which shall be extra heavy, malleable iron, 300 lbs. Fittings shall conform to ASTM A47, Grade 32510 service rating. For galvanized pipe, fittings shall also be hot dipped galvanized and shall conform to ASTM A153. Joints for fittings shall be threaded for standard screwed joints.

D. Where flanged connections are indicated or otherwise required on pipe 2-in or less for connection to flanged valves, fittings and appurtenances, they shall be made up using companion type flanges. Where flanged fittings are indicated or otherwise required, they shall be made up using threaded steel nipples and steel companion type flanges. Companion flanges shall be steel, 150 lb ANSI Standard flat face flanges of the threaded type. Flanges shall be spot faced on the back around each bolt hole. For galvanized pipe, flanges shall also be hot-dipped galvanized.

E. Pipe greater than 2-in size shall have threaded or welded joints. Threaded joints, fittings and flanges shall be as specified above. Pipe shall have beveled ends for welding. Fittings shall be steel, butt weld type. Standard wall, conforming to ANSI B16.9 and ASTM A234, Grade WPB. Flanges shall be steel slip on or welding neck type, raised face, Class 150, conforming to ASTM A105 and ANSI B16.5. Gaskets shall be ring type, 1/16-in thick, I.D. and O.D. as required by pipe size and of approved composition suitable for the intended service. Bolts and nuts for flanges shall be hex head cap screws conforming to ANSI B16.2, coarse threads, Class 2A fit, manufactured of ASTM A307, Grade B steel. Split type couplings as specified in Section 15100 may be used in lieu of flanged or welded joints as approved by the Engineer. Pipe for split type couplings shall have radius grooved ends for a rigid joint.

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2.02 SURFACE PREPARATION AND SHOP PRIME PAINTING

A. All piping and fittings exposed to view shall have its surface prepared and be shop painted as specified in Section 09901. Surface preparation and shop priming is a part of the work of this Section. Pipe finish painting and marking is included in Division 9, but it shall be part of the work of this Section to assist as required by the Engineer in identifying pipe contents, direction of flow and all else required for proper marking of pipe.

PART 3 EXECUTION

3.01 INSTALLATION

A. Steel pipe shall be installed true to alignment, and rigidly supported anchors shall be provided where required under Section 15140 or as shown on the Drawings. After installation, the piping shall be tested as specified in PART 3.

B. All threads shall be clean, machine cut and all pipe shall be reamed before erection. Each length of pipe as erected shall be up-ended and rapped to dislodge dirt and scale.

C. Screwed joints shall be made up with good quality thread compound and applied to the male thread only. After having been set up, a joint must not be backed off unless the joint is completely broken, the threads cleaned and new compound applied. All joints shall be air tight.

D. All piping shall have a sufficient number of unions to allow convenient removal of piping. Unions shall be compatible with pipe.

E. When cutting of pipe is required, the cutting shall be done by machine in a neat workmanlike manner without damage to the pipe. Cut ends shall be smooth and at right angle to the axis of the pipe.

F. All field welding shall be in accordance with the AWS. The strength of the field weld shall develop the strength of the pipe.

3.02 TESTING

A. All pipelines shall be tested for compliance with this Section. If leaks are discovered, they shall be repaired under this Section and approved by the Engineer. Pressure and leakage tests will be required. The test pressures for the various pipelines shall be as follows:

1. Low pressure air piping - 15 psi

3. All other piping - 50 psi

B. After installation, all piping shall be flushed clean and then tested at least 1 hour at the test pressure specified above. If any joint or pipe section proves to be defective, it shall be repaired to the satisfaction of the Engineer.

END OF SECTION

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SECTION 15064

PLASTIC PIPE AND FITTINGS

PART 1 GENERAL

1.01 SCOPE OF WORK

A. Furnish all labor, materials, equipment and incidentals required and install 1/8-in to 6-in non-buried plastic piping and appurtenances as shown on the Drawings and as specified herein.

1.02 RELATED WORK

A. Wall sleeves are included in Section 01180.

B. Buried piping is included under Division 2.

C. Concrete work is included in Division 3.

D. Painting is included in Division 9.

E. Valves and appurtenances are included in Section 15100.

F. Pipe hangers and supports are included in Section 15140.

1.03 SUBMITTALS

A. Submit, in accordance with Section 01300, shop drawings and product data required to establish compliance with this Section. Submittals shall include the following:

1. Shop drawings including piping layouts and schedules shall be submitted to the Engineer and shall include dimensioning, fittings, locations of valves and appurtenances, joint details, methods and locations of supports and all other pertinent technical specifications for all piping to be furnished.

2. Shop drawing submittals for piping under this Section shall include all data and information required for the complete piping systems. All dimensions shall be based on the actual equipment to be furnished. Types and locations of pipe hangers and/or supports shall be shown on the piping layout for each piping submittal.

1.04 REFERENCE STANDARDS

A. American Society for Testing and Materials (ASTM).

1. ASTM D1784 - Standard Specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds.

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2. ASTM D1785 - Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80 and 120.

3. ASTM D2447 - Standard Specification for Polyethylene (PE) Plastic Pipe, Schedules 40 and 80, Based on Outside Diameter.

4. ASTM D2464 - Standard Specification for Threaded Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.

5. ASTM D2466 - Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40.

6. ASTM D2467 - Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.

7. ASTM D2564 - Standard Specification for Solvent Cements for Poly (Vinyl Chloride) (PVC) Plastic Piping Systems.

8. ASTM D2657 - Standard Practice for Heat Fusion Joining of Polyolefin Pipe and Fittings.

9. ASTM D2665 - Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Drain, Waste and Vent Pipe and Fittings.

10. ASTM D2855 - Standard Practice for Making Solvent-Cemented Joints with Poly (Vinyl Chloride) (PVC) Pipe and Fittings.

11. ASTM D3261 - Standard Specification for Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing.

12. ASTM D3311 - Standard Specification for Drain, Waste and Vent (DWV) Plastic Fittings Patterns.

13. ASTM F437 - Standard Specification for Threaded Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80.

14. ASTM F438 - Standard Specification for Socket - Type Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 40.

15. ASTM F439 - Standard Specification for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80.

16. ASTM F441 - Standard Specification for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe, Schedules 40 and 80.

17. ASTM F493 - Standard Specification for Solvent Cements for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe and Fittings.

18. ASTM F593 - Standard Specification for Stainless Steel Bolts, Hex Cap Screws and Studs.

19. ASTM F594 - Standard Specification for Stainless Steel Nuts.

B. Plastic Pipe Institute (PPI)

1. PPI TR31 - Underground Installation of Polyolefin Piping.

C. American National Standard Institute (ANSI)

1. ANSI B16.5 Pipe Flanges and Flanged Fittings.

D. National Sanitation Foundation (NSF)

E. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.05 QUALITY ASSURANCE

A. All plastic pipe and fittings of each type shall be furnished by a single manufacturer who is experienced in the manufacture of the items to be furnished; however, it shall not be a requirement that the pipe and fittings be manufactured by the same manufacturer, provided that the pipe and fittings are compatible in both compounding and size. The pipe and fittings shall be designed, constructed and installed in accordance with the best practices and methods and shall be suitable for the intended service.

1.06 SYSTEM DESCRIPTION

A. Piping shall be installed in those locations as shown on the Drawings.

B. The equipment and materials specified herein are intended to be standard types of plastic pipe and fittings for use in transporting wastewater, water, air and chemicals.

C. Plastic piping systems shall be designed for the following conditions:

| **System:** | **Chlorine Feed System** |
|---|---|
| Material: | Schedule 80 PVC |
| Fluids: | Chlorine Solution |
| Pressure: | Atmosphere to 100 psig |
| Flow Velocity: | Up to 10 fps |
| Temperature: | 35 to 100 degrees F |
| Special Conditions: | Notice special requirements apply for solvent joints. |

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| | |
|---|---|
| **System:** | **Chlorine Diffuser** |
| Material: | HDPE |
| Fluids: | Chlorine Solution |
| Pressure: | Atmosphere to 60 psig |
| Flow Velocity: | Up to 10 fps |
| Temperature: | 35 to 100 degrees F |
| Special Conditions: | Drill holes for diffuser per Drawings.<br>Direct UV Exposure. |
| **System:** | **Drain** |
| Material: | Schedule 80 PVC |
| Fluids: | Wastewater |
| Pressure: | 0 to 15 psi |
| Flow Velocity: | Up to 10 fps |
| Temperature: | 0 to 100 degrees F |
| Special Conditions: | None. |
| **System:** | **Non-Potable Water** |
| Material: | Schedule 80 PVC |
| Fluids: | Chlorinated Final Effluent |
| Pressure: | Atmosphere to 100 psig |
| Flow Velocity: | Up to 10 fps |
| Temperature: | 35 to 100 degrees F |
| Special Conditions: | None. |
| **System:** | **Potable Water** |
| Material: | Schedule 80 PVC |
| Fluids: | Potable Water |
| Pressure: | Atmosphere to 100 psig |
| Flow Velocity: | Up to 10 fps |

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Temperature: 35 to 100 degrees F

Special Conditions: None.

PART 2 PRODUCTS

2.01 MATERIALS

A. Poly (Vinyl Chloride) Pipe and Fittings - PVC

1. Pipe shall be manufactured from PVC compounds meeting ASTM D1784, Class 12454-B in accordance with ASTM D1785, PVC 1120. The pipe shall have a minimum hydrostatic design stress of 2,000 psi at 73 degrees F and shall be suitable for field cutting and solvent welding. Pipe shall be of the sizes as shown on the Drawings and shall be Schedule 80 unless otherwise shown.

2. Fittings shall be the socket type for solvent welded joints conforming to ASTM D2467 or ASTM D2466 where Schedule 40 pipe is shown on the Drawings. Fittings shall be manufactured from PVC compound meeting ASTM D1784, Class 12454-B. Solvent cement shall be as specified in ASTM D2564.

3. Pipe, fittings and solvent for use with potable water shall be certified by NSF in accordance with NSF Standard No. 14 and the seal shall be included on the pipe.

4. For chlorine solution, schedule 80 PVC pipe, the cement shall be Oatey Industrial Grade Low VOC Heavy Duty Gray, by Oatey Corp., Cleveland OH or engineer approved equal.

B. Poly (Vinyl Chloride) Pipe and Fittings for Drain, Waste and Vent Service (DWV).

1. Pipe shall be manufactured from PVC compounds meeting ASTM D1784, Class 12454-B in accordance with ASTM D2665. The patterns, dimensions and laying lengths of fittings including adapters shall meet the requirements of ASTM D3311. Solvent cement for joining DWA pipe and fittings shall be as specified in ASTM D2564.

C. Chlorinated Poly (Vinyl Chloride) Pipe and fittings - CPVC

1. Pipe shall be manufactured from CPVC compounds meeting ASTM D1784, Class 23447 in accordance with ASTM F441, CPVC 4120. The pipe shall have a minimum hydrostatic design stress of 2000 psi at 73 degrees F and 500 psi at 180 degrees F and shall be suitable for field cutting and solvent welding. Pipe shall be of the sizes as shown on the Drawings and shall be Schedule 80 unless otherwise shown.

2. Fittings shall be socket type for solvent weld joints conforming to ASTM F439 or ASTM F438 where Schedule 40 pipe is shown on the Drawings. Fittings shall be manufactured from CPVC compound meeting ASTM D1784, Class 23447. Solvent cement shall be as specified in ASTM F493.

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D. Polyethylene Pipe and Fittings - HDPE

1. Pipe shall be manufactured from High Density Polyethylene (HDPE) base resin conforming to Grade P34 (PPI PE3406 or better) in accordance with the requirements of ASTM D2447. The pipe shall have a minimum hydrostatic design stress of 630 psi at 73 degrees F and be suitable for field cutting and heat fusion joining. Pipe shall be of the sizes shown on the Drawings and shall be Schedule 80 unless otherwise shown. Pipe shall be manufactured with a minimum of 2% carbon black to provide UV resistance.

2. Fittings shall be the butt type for heat fusion joints conforming to ASTM D3261, except that Schedule 80 fittings shall meet the sustained pressure test conditions as specified for Schedule 80 pipe in Table 3 of ASTM D2447. Fittings shall be manufactured from the same HDPE base resin, conforming to Grade P34, Class C (PPI PE3406 or better), as is used to produce the pipe to which the fittings are to be joined. Both pipe and fittings shall be manufactured by the same manufacturer to assure compatibility of the piping system components.

E. Threaded joints shall be as specified under the applicable ASTM standard for the pipe and fittings being used. Thread sealer shall be thread tape which shall be standard industrial quality Teflon, Type 1.

F. Flanged Joints

1. Where flanged joints are shown on the Drawings, they shall be supplied with 1/8-in thick full-faced Viton-N gaskets or equal.

2. Flange bolt spacing, number and dimensions shall conform to the requirements of ANSI B16.5. CPVC and PVC flanges shall be suitable for solvent cementing to the pipe and shall be suitable for a minimum pressure of 150 psi.

3. Bolts, nuts and washers for flanged joints shall be for corrosive service conditions and shall be ASTM F593 and F594, Type 316 stainless steel. Anti-seize compound for stainless steel bolts and nuts shall be of a molybdenum disulfide base such as Molycoat-G or equal.

G. Fittings, specials, unions and flanges shall be of the same schedule number and manufactured of the same materials as the pipe. Whenever unions are called out on the Drawings, flanged connections may be substituted, provided that dimensional controls do not preclude use of flanges.

H. Sleeves for plastic pipe shall be as specified in Section 01172.

I. Expansion joints for PVC and CPVC sizes 1/2-in to 6-in shall be telescoping type as manufactured by Plastinetics, Inc.; ASAHI/America or equal. Expansion in pipes smaller than 1/2-in shall be accommodated with expansion loops.

2.02 SURFACE PREPARATION AND SHOP COATING

A. Painting will not be required on PVC or HDPE pipe, however, marking the pipe to indicate normal direction of flow and the fluid being transported in accordance with the marking

schedule included in Section 09902 shall be required as part of the work of this Section. Marking systems consisting of mylar/aluminum sandwich sheets held in place by mastic or adhesive compounds which are compatible with the HDPE resin used to manufacture the pipe shall be used to identify pipe contents and direction of flow.

## PART 3 EXECUTION

### 3.01 INSTALLATION

A. The installation of plastic pipe shall be strictly in accordance with the manufacturer's technical data and printed instructions.

B. Joints for PVC and CPVC pipe shall be solvent cemented unless flanged or threaded are otherwise shown on the Drawings or are specified as other types herein. In making solvent cemented connections, clean dirt and moisture from pipe and fittings, bevel pipe ends slightly with emery cloth to remove any shoulder or burrs created by cutting of the pipe. Solvent cement joints shall be made in accordance with ASTM D2855 except that solvent cement formulated especially for and as specified above shall be used for joining CPVC pipe and fittings. Primer shall be used whenever recommended by the pipe, fitting, or cement manufacturer and in all cases for joints on pipe systems 4-in in diameter or larger. Making solvent cement joints shall not be performed and the work shall stop when the temperature, measured in the shade, is 40 degrees F and falling.

C. Joints between PVC drain, waste and vent pipe and cast-iron soil pipe shall be made with approved mechanical compression joints designed for such use.

D. Joints for HDPE pipe shall be butt heat fusion. Butt heat fusion joints shall be made in accordance with the requirements of ASTM D2657.

E. Installation of valves and fittings shall be in accordance with manufacturer's instructions. Particular care shall be taken not to overstress threaded connections. In making solvent cement connections, the solvent cement or primer shall not be spilled on valves. Any cement allowed to run from joints shall be cleaned from the pipe and fittings immediately.

F. All piping shall have a sufficient number of unions to allow convenient removal of piping and shall be as approved by the Engineer. PVC and CPVC pipe shall be installed with at least one expansion joint or loop near the center of each straight run of pipe which is 50-ft or longer with the maximum spacing between expansion joints or loops being 150-ft.

G. Where plastic pipe passes through wall sleeves, the space between the pipe and sleeve shall be sealed with a mechanical sealing element as specified in Section 01172.

H. All plastic pipe to metal pipe connections shall be made using flanged connections. Metal piping shall not be threaded into plastic fittings, valves, or couplings nor shall plastic piping be threaded into metal valves, fittings or couplings. Only socket to thread adaptors shall be used for threaded plastic pipe connections to other threaded devices.

I. Concrete inserts for hangers and supports shall be furnished and installed in the concrete as it is placed. The inserts shall be set in accordance with the requirements of the piping layout and

the Contractor shall verify these locations from approved piping layout drawings and the structural drawings. Pipe hangers and supports are specified in Section 15140.

J. Due to its large coefficient of thermal expansion, HDPE pipe shall be installed at its maximum operating temperature to prevent sagging between the hangers or supports. Supports at each end of the straight HDPE pipe runs shall be of sufficient strength to develop anchoring forces adequate to oppose the tensile forces developed in the pipe due to thermal contraction. The exception to this requirement shall be for flanged HDPE connections, because, if the flanged connection is made up at the maximum operating temperature, the thermal contraction of the flange thickness will reduce the required tensile force in the flange bolts. Flanged HDPE connections shall, therefore be made up at the lowest expected operating temperature and then the entire piping system shall be brought up to the maximum operating temperature for final installation. (Note: Packing the flanges in ice may be necessary to achieve the proper installation temperature).

3.02 FIELD TESTING

A. All pipelines shall remain undisturbed for the minimum curing or cooling time specified for each type of pipe material but no less than 8 hours to develop full curing and complete strength at all joints. All pipe systems shall be flushed clean and then subjected to a hydrostatic pressure test for 12 hours at a test pressure and temperature specified below. Testing procedures shall be as specified below and in Section 15051. Should the temperature not be attainable under hydrostatic conditions, then the test may be performed under hydro-dynamic conditions, provided that accurate measurements for loss of the test fluid can be made, or the pressure shall be proportionally increased to simulate the stresses of the higher temperature in relation to the lowest system temperature that is expected during the duration of the test. The proportionally higher test pressures shall be determined in accordance with the accepted temperature versus strength properties as published by the pipe manufacturer, PPI or other pipe material standards organization. Allowance for expansion of polyethylene pipe during the test shall be made in accordance with PPI Technical Report TR31.

B. The test pressures and temperatures for the various pipe lines shall be as follows:

1. Chemical feed piping: 150 psi at 100 degrees F.
2. Drain piping: 15 psi at ambient temperature
3. Non-Potable Piping 150 psi at 100 degrees F
4. Potable Piping 150 psi at 100 degrees F

C. The test shall be performed by slowly filling the piping system, expelling entrapped air from all high points. The fill rate shall be controlled so that the fluid velocity within the pipe system is less than 2 fps. Upon completion of the filling process, the system shall be brought up to the specified test temperature as applicable, holding the system pressure to less than 10 percent of the test pressure. Once the system has been stabilized at the specified test temperature, the pipe should be slowly brought up to the test pressure in such a manner so as to not create shock, surge or water hammer in the pipe system. The test duration time limit shall not begin until the full pressure specified above has been reached and the system has been stabilized to within 5 percent of the test temperature. The system pressure and

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temperature shall be maintained to within 1/2 percent but no more than 5 percent of the specified value for the temperature and within 5 psi of the specified value for the pressure. These tolerances shall be held for the entire duration of the test. Upon completion of the test, the pressure shall be slowly removed by opening a valve or other pressure relieving device at a location remote to the location of the pressure/temperature monitoring equipment.

D. The pressure test shall be monitored by a recording type pressure gauge for tests not requiring temperature control or a dual pen pressure/temperature recording gauge when temperature control is required. The entire test process shall be recorded, including the initial temperature stabilization and pressurization of the piping system. The record shall be continuous through the system test and shall show the final de-pressurization of the pipe system.

E. All visible leaks detected during the pressure test shall be repaired and the pressure/ temperature test rerun. A successful test shall be a test in which no visible leaks are detected and the pipe system pressure can be maintained within 1/2 percent but no more than 5 psi of the specified value.

F. Prior to testing, the pipelines shall be supported in an approved manner to prevent movement during the tests.

3.03 PAINTING

A. All PVC and CPVC pipe and fittings exposed to the direct sunlight shall be field painted to provide additional UV protection. This painting shall be required whether or not marking is required and shall be in accordance with Section 09901.

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SECTION 15066

STAINLESS STEEL PIPE AND FITTINGS

PART 1 GENERAL

1.01 SCOPE OF WORK

A. Furnish all labor, materials, equipment and incidentals required and install, test, complete and ready for operation all stainless steel pipe as shown on the Drawings and as specified herein.

B. Where the word "pipe" is used it shall refer to pipe, fittings, hangers, supports and appurtenances unless otherwise noted.

C. The work includes, but is not necessarily limited to furnishing and installing stainless steel pipe, fittings and specials with screwed, butt welded, or flanged and plain ends.

1.02 RELATED WORK

A. Testing is included in Section 15051

B. Concrete work is included in Division 3.

C. Valves and appurtenances are included in Section 15100.

D. Pipe hangers and supports are included in Section 15140.

E. Thermal insulation is included in Section 15250.

1.03 SUBMITTALS

A. Submit, in accordance with Section 01300, the following:

1. Shop drawings including piping layouts and schedules, including dimensioning, fittings, expansion joints, locations of valves and appurtenances, joint details, wall penetration details, methods and locations of supports and all other pertinent technical specifications for all piping to be furnished. Shop drawings shall include all data and information required for the complete piping systems. All dimensions shall be based on the actual equipment to be furnished. Types and locations of pipe hangers and/or supports shall be shown on the piping layouts for each pipe submittal. Not all dimensions will be checked by the Engineer, nor will detailed review be performed. Contractor shall be responsible for accurate dimensioning of piping systems.

2. Certifications that welders are qualified, in accordance with ANSI B31.1, Paragraph 127.5 for shop and project site welding of pipe work.

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1.04 REFERENCE STANDARDS

A. American Society for Testing and Materials (ASTM)

1. ASTM A312 - Standard Specification for Seamless and Welded Austenitic Stainless Steel Pipes.

2. ASTM A530 - Standard Specification for General Requirements for Specialized Carbon and Alloy Steel Pipe.

3. ASTM A778 - Standard Specification for Welded, Unannealed Austenitic Stainless Steel Tubular Products.

B. American National Standards Institute (ANSI)

1. ANSI B16.1 - Cast Iron Pipe Flanges and Flanged Fittings Classes 25, 125 and 250.

2. ANSI B16.9 - Factory-Made Wrought Steel Buttwelding Fittings.

3. ANSI B36.19 - Stainless Steel Pipe

C. American Water Works Association (AWWA)

1. AWWA C111 - Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.

D. American Society of Mechanical Engineers (ASME)

1. ASME B31.1 - Power Piping.

E. American Welding Society (AWS)

F. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.05 QUALITY ASSURANCE

A. Stainless steel pipe and fittings shall be furnished by a single manufacturer who is fully experienced, reputable, qualified and regularly engaged for the last 5 years in the manufacture of the materials to be furnished. The pipe and fittings shall be designed, constructed and installed in accordance with the best practices and methods and shall comply with this Section.

1.06 SYSTEM DESCRIPTION

A. Piping shall be installed in those locations as shown on the Drawings.

B. The equipment and materials specified herein are intended to be standard types of stainless steel pipe and fittings for use in transporting air.

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C. Stainless steel piping for the system listed below shall be designed for the following conditions:

1. System: Aeration Air

a. Material: Type 316L

b. Operating Air Pressure: 9 psi

c. Test Air Pressure: 21 psi

1.07 DELIVERY, STORAGE AND HANDLING

A. Care shall be taken in loading, transporting and unloading to prevent injury to the pipe and fittings. Pipe and fittings shall not be dropped. Pipe and fittings shall be examined before installation and no piece shall be installed which is found to be defective.

B. In handling the pipe, wide cushioned slings or other devices and methods acceptable to the Engineer shall be used. No uncushioned ropes, chairs, wedges or levers shall be used in handling the pipe, fittings and couplings.

C. If any defective pipe is discovered after it has been installed, it shall be removed and replaced with a sound pipe by the Contractor, at the Contractor's own expense. All pipe and fittings shall be thoroughly cleaned before installation and shall be kept clean until they are put into service.

PART 2 PRODUCTS

2.01 MATERIALS

A. All stainless steel pipe and fittings 8-in and larger shall be fabricated from stainless steel sheet and conform to ASTM A778 Type 304L. All stainless steel pipe and fittings 6-in and less shall be fabricated from stainless steel sheet and conform to ASTM A778 Type 316L. Carbon content of Type 316L material shall be 0.03 percent maximum. Finish shall be No. 1 or No. 2B.

B. Pipe shall be die-formed or rolled true to dimension and round. Tolerances for length, inside and outside diameter and straightness shall conform to ASTM A530. The two edges of sheet shall be brought to line so as not to leave a shoulder on the inside of the pipe. Ends of pipe and fittings shall be perpendicular to the longitudinal axis. Longitudinal seams on pipe and fittings shall be welded by either the tungsten gas or the metallic-gas method. The interior welds shall be smooth, even and shall not have an internal bead higher than 1/16-in. All pieces shall be marked with gauge and type of stainless steel and with the initials of the inspector marked on the inside of each piece, at each end.

C. Pipe and fittings shall be supplied with the appropriate wall thicknesses but not thinner than 16 gauge.

D. Fittings shall be smooth curve type up to 18-in diameter and mitered type 20-in diameter and greater. Fittings shall conform to ANSI B16.9.

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E. Flanges for pipe 4-in and smaller shall be of the type of stainless steel as the pipeline, and shall be welded directly to the pipe end, and shall be drilled to the 125 lb ANSI B16.1 standard. Flanges for pipe larger than 4-in shall have stub ends or rolled angle rings of the type of stainless steel as the pipeline welded to the pipe end, with suitable gaskets between the mating surfaces and joined through the use of 125 lb rated back-up flanges, drilled to ANSI B16.1, and made of Type 316 stainless steel materials as shown on the Drawings. Where the pipe stub is to pass through a sleeve during installation, a split-type back up flange shall be used. Bolts, washers, nuts and other hardware for flange bolting shall be Type 316 stainless steel.

F. Gaskets for flanged connections shall be a minimum of 1/16-in thick and shall be viton.

G. Shop fabricated multiple output headers may be used in lieu of individual flanged fittings.

H. Wall pipes shall have integral shop welded wall stops.

I. All stainless steel pipe and fittings shall be pickled at the point of manufacture, scrubbed and washed until all discoloration is removed in accordance with ASTM A380J. Pipe ends shall be prepared for couplings or other type ends where required by transport and handling limitations, where required by the support layout requirements and where noted on the Drawings. Plain end pipe may be coupled with "Pressfit"-style connectors, for pipe/tubing sizes 1-1/2-in and smaller, manufactured by the Victaulic Co. or by the use of grooved end couplings. Grooving (or built-up ends for Schedule 5s or 10s pipe) shall be of the coupling manufacturers standard type. Contractor is responsible for ensuring rigidity of joints where required. All normal pipe joints at valves, bends, etc, shall be flanged, drilling per ANSI B16.1, Class 125.

K. Shop welding of fabrications shall be done according to the procedures and by welders certified per ASME Section IX. Welds shall be by an inert gas shielding process using only extra low carbon filler metals. Welds shall have a bead height of no more than 1/16-in. Butt welds shall have 100 percent penetration to the interior or backside of the weld joint. Cross-sectional thickness of welds shall be equal or greater than that of the parent metal.

L. Where shown on the Drawings or where approved by the Engineer, plain end pipe shall be joined by all stainless steel flexible couplings. Sleeve type couplings shall be of the Type 316L stainless steel and shall be Style 38 as manufactured by Dresser Manufacturing Division of Dresser Industries; coupling 411 as manufactured by Smith Blair, Inc. or equivalent couplings manufactured by Depend-O-Lok Co.

M. Where shown on the Drawings or where approved by the Engineer, flanged coupling adaptors shall be used to connect plain end pipe to equipment, fittings and valves. Flanged coupling adaptors shall be of the Type 316L stainless steel and shall comply with AWWA C207. Flanged coupling adapters shall be manufactured by Dresser Manufacturing Division of Dresser Industries; Smith Blair, Inc. or equal.

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PART 3 EXECUTION

3.01 INSTALLATION

A. All pipe and fittings shall be installed true to grade and alignment and pipe anchorage and/or restraint shall be provided where required. Manufacturer's instructions shall be strictly followed.

B. All pipe and fittings shall be protected from dirt, dust, oil, grease and other foreign matter during installation to prevent damage to pipe and to assure no foreign matter is left in the piping.

C. To assemble the joints in the field, thoroughly clean all joint surfaces and gaskets, if any, with soapy water before assembly. Bolts shall be tightened alternately, evenly to the manufacturer's specified torques. Under no condition shall extension wrenches or pipe-over-handle ratchet wrenches be used to secure greater leverage. All electrical bonding or insulation shall be installed as joints are made up.

D. Fittings, in addition to those shown on the Drawings, shall be provided if required. Due consideration shall be given to thermal expansion/contraction over a temperature range of 200 degrees F.

E. Sleeves of the proper size shall be installed for all pipes passing through floors or walls as shown on the Drawings. Sleeves shall be as specified in Section 01180.

F. When cutting of pipe is required, the cutting shall be done by machine neatly, without damage to the pipe. Cut ends shall be smooth and at right angles to the axis of the pipe.

G. After installation, stainless steel pipe lines shall be washed clean with steam or hot water to remove any foreign material picked up during transport.

3.02 JOINING MECHANICAL AND RESTRAINED JOINTS

A. Mechanical joints shall be in accordance with the "Notes on Methods of Installation" under AWWA C111 and the instructions of the manufacturer.

B. Restrained joint pipe and fittings shall be installed in the locations shown on the Drawings and as acceptable to the Engineer.

3.03 JOINING FLANGED JOINTS

A. Flanged joints shall be made with gasket, bolts and nut bolts stud with a nut on each end, or studs with nuts where the pipe is tapped. The number and size of bolts shall conform to the same standard requirements as the flange.

3.04 FIELD WELDING

A. Welding in the field shall be done only if approved by the Engineer. Field welds shall be made by welders certified under ASME Section IX and be equal in all respects to shop welds.

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After field welding has been done, all joints shall be thoroughly cleaned and buffed using deburring and finishing wheels.

3.05 FIELD PAINTING

A. Final field painting is included in Section 09902 except that for all stainless steel pipe, only bands, labels and arrows rather than full pipe painting will be required.

3.06 DISINFECTION AND CLEANUP

A. After installation, completed lines shall be cleaned with Oakite deoxidizer or similar deoxidizer as recommended by the manufacturer to remove all foreign matter, construction stains or shop markings. Cleaned lines shall be rinsed clear with steam or hot water.

3.07 FIELD TESTING

A. Field Testing of the pipe is specified in Section 01445.

END OF SECTION

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SECTION 15072

DUCTILE-IRON PIPE AND FITTINGS

PART 1 GENERAL

1.01 SCOPE OF WORK

A. Furnish all labor, materials, equipment and incidentals required and install all non-buried ductile-iron piping, gray-iron or ductile-iron fittings and appurtenances as shown on the Drawings and as specified herein.

1.02 RELATED WORK

A. Buried pipe is included in Division 2.

B. Concrete work is included in Division 3.

C. Field painting, except as specified herein, is included in Section 09902.

E. Pipe testing is included in Section 01445.

F. Valves and appurtenances are included in Section 15100.

G. Piping Specialties are included in Section 15120

H. Pipe hangers and supports are included in Section 15140.

I. Pipe insulation is included in Section 15250.

1.03 SUBMITTALS

A. Submit, in accordance with Section 01300, a list of materials to be furnished, the names of the suppliers and the date of delivery of materials to the site. Submittals shall include the following:

1. Shop drawings including piping layouts, schedules, including dimensioning, fittings, locations of valves and appurtenances, joint details, methods and locations of supports and all other pertinent technical specifications for all piping to be furnished.

2. Shop drawing submittals for piping under this Section shall include all data and information required for the complete piping systems. All dimensions shall be based on the actual equipment to be furnished. Types and locations of pipe hangers and/or supports shall be shown on the piping layouts for each piping submittal.

3. Certification that all pipe supplied under this Section complies with all reference standards specified.

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1.04 REFERENCE STANDARDS

A. American Society for Testing and Materials (ASTM)

1. ASTM A307 - Standard Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength.

B. American Water Works Association (AWWA)

1. AWWA C104 - Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water.

2. AWWA C110 - Ductile-Iron and Gray-Iron Fittings, 3-in Through 48-in (75mm Through 1200mm), for Water and Other Liquids.

3. AWWA C111 - Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.

4. AWWA C115 - Flanged Ductile-Iron Pipe with Ductile-Iron or Gray-Iron Threaded Flanges.

5. AWWA C151 - Ductile-Iron Pipe, Centrifugally Cast for Water or Other Liquids.

6. AWWA C606 - Grooved and Shouldered Joints.

7. AWWA C153 – Ductile-Iron Compact Fittings for Water Service.

C. Where reference is made to one of the above standards, the reference in effect at the time of bid opening shall apply.

1.05 QUALITY ASSURANCE

A. Each length of ductile iron pipe supplied for the project shall be hydrostatically tested at the point of manufacture to 500 psi for a duration of 10 seconds per AWWA C151. Testing may be performed prior to machining bell and spigot. Failure of ductile iron pipe shall be defined as any rupture of the pipe wall. Certified test results shall be furnished in duplicate to the Engineer prior to time of shipment.

B. All ductile-iron pipe and fittings to be installed under this project shall be inspected and tested at the foundry as required by the standard specifications to which the material is manufactured. Furnish in duplicate to the Engineer sworn certificates of such tests and their results prior to the shipment of the pipe.

C. All pipe and fittings to be installed under this Contract may be inspected at the plant for compliance with this Section by an independent testing laboratory selected by the Owner, at the Owner's expense.

D. Inspection of the pipe and fittings will also be made by the Engineer or representative of the Owner after delivery. The pipe shall be subject to rejection at any time on account of failure to meet any of the specified requirements, even though sample pipes may have been accepted as satisfactory at the place of manufacture. Pipe rejected after delivery shall be marked for identification and shall be removed from the job.

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E. All pipe and fittings shall be permanently marked with the following information:

1. Manufacturer, date.

2. Size, type, class, or wall thickness.

3. Standard produced to (AWWA, ASTM, etc).

1.06 DELIVERY, STORAGE AND HANDLING

A. See Section 01600 for general requirements.

B. Care shall be taken in loading, transporting and unloading to prevent injury to the pipe or coatings. Under no circumstances shall the pipe be dropped or skidded against each other. Slings, hooks, or pipe tongs shall be padded and used in such a manner as to prevent damage to the exterior surface or internal lining of the pipe.

C. Materials, if stored, shall be kept safe from damage. The interior of all piping, fittings and other appurtenances shall be kept free from dirt or foreign matter at all times.

D. Pipe shall not be stacked higher than the limits recommended by its manufacturer. The bottom tier shall be kept off the ground on timbers, rails, or concrete. Stacking shall conform to manufacturer's recommendations.

1.07 PLANT INSPECTION

A. All ductile-iron pipe and gray-iron or ductile-iron fittings to be installed under this Contract shall be inspected and tested at the foundry as required by the standard specifications to which the material is manufactured. Furnish in duplicate to the Engineer sworn certificates of such tests and their results. In addition all ductile-iron pipe and fittings to be installed under this Contract may be inspected at the foundry for compliance with this Section by an independent testing laboratory selected by the Owner. The manufacturer's cooperation shall be required in these inspections. The cost of foundry inspection of all pipe approved for this Contract, plus the cost of inspection of a reasonable amount of disapproved pipe (125 percent of the total length of each diameter required), will be borne by the Owner.

PART 2 PRODUCTS

2.01 MATERIALS

A. Ductile iron pipe shall conform to AWWA C115, Thickness Class 53, maximum working pressure of 250 psi. Flanges shall be faced and drilled after being screwed on the pipe, with flanges true to 90 degrees with the pipe axis and shall be flush with end of pipe. Gaskets shall be ethylene propylene (EPDM) 1/8-in thick and shall conform to the dimensions shown in Table A.1 of AWWA C115.

1. Flanged joints shall be supplied with bolts, bolt studs with a nut on each end, or studs with nuts where the flange is tapped. The number and size of bolts shall conform to the same ANSI standard as the flange. Bolts and nuts shall, except as otherwise specified or noted on the Drawings, conform to the ASTM A307, Grade B.

2. Mechanical joint ductile iron pipe shall conform to AWWA C151 and C111 as applicable.

3. Pipe for use with split-type flexible coupling joints shall have radius grooved ends conforming to AWWA C606.

4. Fittings shall be ductile iron or gray-iron as specified above. Except as specified below, flanges and flanged fittings shall conform to AWWA C110 or AWWA C153 for 150 psi minimum pressure rating. Fittings shall have the same minimum pressure rating as the pipe to which they are attached.

5. All gravity and pressurized piping installed to convey primary effluent (PE), return activated sludge (RAS), waste activated sludge (WAS), scum (SSC), mixed liquor (ML), and secondary clarifier effluent (SCE), and all fittings connected to these pipelines shall be lined with a ceramic-filled amine-cured epoxy, Protecto 401 by Induron, SP2000 by Fast Fabricators, or approved equal. The lining thickness shall be 40 mils minimum. Application shall be performed by an applicator approved by the coating manufacturer, in accordance with manufacturer's instructions and under controlled conditions at the applicator's shop or the pipe manufacturer's plant. Applicator shall submit a certified affidavit of compliance with manufacturer's instructions and requirements specified herein: Potable and Non-Potable water lines and fittings shall have a cement mortar lining in accordance with AWWA C104.

6. Pipe and fittings exposed to view in the finished work shall not receive the standard asphalt coating but shall be shop primed on the outside in accordance with Section 09901. All other pipe and fittings shall be shop coated on the outside with bituminous coating in accordance with the above referenced standards and will not require any other coating. If it is necessary to use bituminous coated pipe in exposed areas, the coating shall be completely removed by blast cleaning and the cleaned surfaces shall be immediately primed as specified in Section 09901.

7. Split Type Couplings

   a. Split type couplings shall conform to AWWA C606.

   b. Pipe ends for use with split type couplings shall have grooved ends to provide either a rigid joint or flexible joint as required by the Drawings or as specified herein.

   c. Flexible joint grooving shall permit expansion and contraction and angular deflection. Rigid joint grooving shall allow no angular or linear movement.

   d. Split type couplings with rigid grooving may be used in lieu of flanged connections. However, the location and the number and type of joints shall be subject to the approval of the Engineer.

   e. Flanged adaptor connections for grooved or shouldered end pipe compatible with split couplings at fittings, valves and equipment shall be VIC-Flange Style 341 (ductile iron pipe and VIC-Flange Style 741/743 (for steel and stainless steel pipe) by the Victaulic Company of America, equal by Depend-O-Lok F x F FAC by Victaulic Depend-O-Lok Inc or equal.

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8. Sleeve Type Couplings

   a. Sleeve-type couplings shall be as made by Dresser Mfg. Div., Bradford, PA; Smith-Blair, Inc., San Francisco, CA; R.H. Baker & Co., Inc., Huntington Park, CA or equal.

   b. Couplings for exposed pipe shall be of steel and shall be Dresser Style 38; Smith-Blair Style 413; Baker Allsteel or equal. The couplings shall be provided with black steel bolts and nuts unless indicated otherwise.

   c. All couplings shall be furnished with the pipe stop removed.

   d. Couplings shall be provided with gaskets of a composition suitable for exposure to the liquid within the pipe.

   e. Flanged adapter connections shall be Megaflange by Ebba Iron Inc. with no equal.

9. Wall castings shall be of the sizes and types shown on the Drawings. Flanges and/or mechanical joint bells shall be drilled and tapped for studs where flush with the wall.

10. Wall castings shall be provided with an intermediate wall collar. The collar shall be located at the center of the overall length of casting for castings set flush with the wall. For castings which extend through the wall, the collar shall be located such that it is within the middle third of the wall. Collars shall either be cast integrally with the casting or shall be of the assembled type as manufactured by U.S. Pipe & Foundry Company, consisting of two mechanical joint retainer glands with gasket.

11. Base bends and base tees shall have machined and drilled bases.

12. Filler flanges and beveled filler flanges shall be furnished and installed as required. Filler flanges and beveled filler flanges shall be furnished faced and drilled complete with extra length bolts. Filler flanges shall be equal to Clow Fig. F-1984 and beveled filler flanges shall be equal to Clow Fig. F-1986.

## 2.02 SURFACE PREPARATION AND SHOP PRIME PAINTING

A. All piping and fittings exposed to view shall have its surface prepared and be shop painted as specified in Section 09901. Surface preparation and shop priming is a part of the work of this Section. Pipe finish painting and marking is included in Section 09902, but it shall be part of the work of this Section to assist as required by the Engineer in identifying pipe contents, direction of flow and all else required for proper finish painting and marking of pipe.

# PART 3 EXECUTION

## 3.01 HANDLING PIPE AND FITTINGS

A. Care shall be taken in loading, transporting and unloading to prevent injury to the pipe or coatings. Pipe or fittings shall not be dropped. All pipe or fittings shall be examined before installing, and no piece shall be installed which is found to be defective. Any damage to the pipe linings or coatings shall be repaired as directed by the Engineer.

B. All pipe and fittings shall be subjected to a careful inspection and hammer test just prior to being installed.

C. If any defective pipe is discovered after it has been installed it shall be removed and replaced with a sound pipe in a satisfactory manner. All pipe and fittings shall be thoroughly cleaned before installing, shall be kept clean until they are used in the work and when installed shall conform to the lines, grades and dimensions required.

3.02 INSTALLATION

A. All piping and fittings shall be installed true to alignment and rigidly supported thrust anchors shall be provided where required. Any damage to linings or coatings shall be repaired to the satisfaction of the Engineer before the pipe is installed. Each length of pipe shall be cleaned out before erection.

B. Sleeves shall be installed of proper size for all pipes passing through floors or walls as shown on the Drawings. Where indicated on the Drawings or required for liquid or gas-tightness the pipe shall be sealed as specified in Section 01172.

C. Concrete inserts for hangers and supports shall be furnished and installed in the concrete as it is placed. The inserts shall be set in accordance with the requirements of the piping layout and jointing method and their locations shall be verified from approved piping layout drawings and the structural drawings. Pipe hangers and supports are specified in Section 15140.

D. Except as otherwise shown on the Drawings either split type couplings or flange joints may be used. Split type couplings used in place of flanged joints shall use rigid grooving. Split type couplings located as shown on the Drawings with flexible grooving shall be used regardless of whether adjacent joints use flanges or split type couplings. Prior to approval of joint method, layouts for hanger and supports shall be submitted to the Engineer for approval. Pipe for use with non-restrained sleeve type couplings shall have plain ends. Pipe for use with split type couplings shall have radius grooved ends.

E. Flanged joints shall be made with opposite bolts tightened alternately and evenly.

F. Prior to assembly of split couplings, the grooves as well as other parts shall be thoroughly cleaned. The ends of the pipes and outside of the gaskets shall be moderately coated with petroleum jelly, cup grease, soft soap, or graphite paste and the gasket shall be slipped over one pipe end. After the other pipe has been brought to the correct position, the gasket shall be centered over the pipe ends with the lips against the pipes. The housing sections then shall be placed. After the bolts have been inserted, the nuts shall be tightened until the housing sections are firmly in contact, metal-to-metal, without excessive bolt tension.

G. All valves, fittings, equipment and appurtenances needed on the pipelines shall be set and jointed as indicated on the Drawings or as required. All pipe and appurtenances connected to equipment shall be supported in such a manner as to prevent any strain being imposed on the equipment. When manufacturers have indicated requirements that piping loads shall not be transmitted to their equipment, a certification shall be submitted stating that such requirements have been complied with.

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3.03 TESTING

A. All pipelines shall be tested for compliance with the requirements specified in Section 01445. If leaks are discovered, they shall be repaired under this Section and approved by the Engineer. Pressure and leakage tests will be required. All pipe and fittings shall be pressure tested using water to 1.5 times the working pressure for 1 hour and the pipeline and fittings shall show no sign of leakage.

B. After installation, all interior ductile-iron piping shall be flushed clean and then tested at least 1 hour at the specified test pressure. If any joint or pipe section proves to be defective, it shall be repaired to the satisfaction of the Engineer and lines retested.

3.04 INSULATION

A. All protected and plant water piping exposed to view shall be insulated in a manner identical to that specified under Section 15250. All insulation for protected and plant water piping shall be furnished and installed under this Section.

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SECTION 15100

VALVES AND APPURTENANCES

PART 1 GENERAL

1.01 SCOPE OF WORK

A. Furnish all labor, materials, equipment, and incidentals required, and install complete and ready for operation, all valves and appurtenances as shown on the Drawings and as specified herein.

B. The equipment shall include, but not be limited to, the following:

1. Gate valves
2. Plug valves
3. Check valves
4. Ball valves
5. Globe valves
6. Butterfly valves for air service
7. Solenoid valves
8. Unions
9. Flexible connections
10. Plugs and caps
11. Miscellaneous adapters
12. Vents and drains
13. Cleanouts
14. Yard and post hydrants
15. Corporation cocks
16. Diaphragm seals
17. Service clamps
18. Dielectric connections

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19. Combination air valves

20. Mud valves

1.02 RELATED WORK

A. Excavation, backfill, fill and grading is included in Division 2.

B. Piping is included in the respective Sections of Divisions 2 and 15.

C. Field painting is included in Section 09902.

D. Instrumentation and control work, except as specified herein, is included in Division 13. Instrumentation and controls provided in this section shall adhere to Instrumentation and Control Specifications Sections in Division 13.

E. Pipe Hangers and supports are included in Section 15140.

F. Valves on all Plumbing systems are included in Section 15400.

G. Electrical is included in Division 16.

1.03 SUBMITTALS

A. Submit, in accordance with Section 01300, copies of all materials required to establish compliance with this Section. Submittals shall include the following:

1. Certified drawings showing all important details of construction and dimensions.

2. Descriptive literature, bulletins, and/or catalogs of the equipment.

3. All information required by Section 01170.

4. The total weight of each item.

5. A complete total bill of materials.

6. A list of the manufacturer's recommended spare parts.

B. Operation and Maintenance Data

1. Operating and maintenance instructions shall be furnished to the Engineer as provided in Section 01730. The instructions shall be prepared specifically for this installation and shall include all required cuts, drawings, equipment lists, descriptions that are required to instruct operating and maintenance personnel unfamiliar with such equipment.

C. Statement of Conformance

1. Provide a Statement of Conformance letter stating conformance to the Drawings and Specifications with all exceptions noted. Statement of conformance must be signed by an

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individual authorized to make such statements. Omission of the Statement of Conformance letter or failure to note all exceptions to the Drawings and Specifications is justification for submittal rejection.

1.04 REFERENCE STANDARDS

A. American Society for Testing and Materials (ASTM)

1. ASTM A48 - Standard Specification for Gray Iron Pipe.
2. ASTM A126 - Standard Specification for Gray Iron Casting for Valves, Flanges and Pipe Fittings.
3. ASTM A436 - Standard Specification for Austentic Gray Iron Castings.
4. ASTM A536 - Standard Specification for Ductile Iron Castings
5. ASTM B30 - Standard Specification for Copper-Based Alloys in Ingot Form.
6. ASTM B62 - Standard Specification for Composition Bronze or Ounce Metal Castings.
7. ASTM G8 - Standard Test Methods for Cathodic Disbonding of Pipeline Coatings.

B. American Society of Mechanical Engineers (ASME)

1. ASME B2.1 - Specifications, Dimensions, Gauging for Taper and Straight Pipe Threads (except dry seals).
2. ASME B16.1 - Cast Iron Pipe Flanges and Flanged Fittings.

C. American Water Works Association (AWWA)

1. AWWA C111 - Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
2. AWWA C504 - Rubber-Seated Butterfly Valves
3. AWWA C508 - Swing-Check Valves for Waterworks Service 2-in (50-mm) Through 24-in (600mm) NPS.
4. AWWA C509 - Resilient-Seated Gate Valves for Water Supply Service
5. AWWA C512 - Air Release, Air/Vacuum, and Combination Air Valves for Waterworks Service
6. AWWA C517 - Resilient-Seated Cast-Iron Eccentric Plug Valves
7. AWWA C550 - Protective Interior Coatings for Valves and Hydrants
8. AWWA C800 - Underground Service Line Valves and Fittings.

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D. American National Standards Institute (ANSI)

E. The Society for Protective Coatings (SSPC)

1. SSPC SP5 - Surface Preparation Specification No. 5 White Metal Blast Cleaning.

F. National Electrical Manufacturers Association (NEMA)

G. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.05 QUALITY ASSURANCE

A. All of the types of valves and appurtenances shall be the product of well established firms who are fully experienced, reputable and qualified in the manufacture of the particular equipment to be furnished. The equipment shall be designed, constructed and installed in accordance with the best practices and methods and shall comply with this Section as applicable.

1.06 SYSTEM DESCRIPTION

A. All of the equipment and materials specified herein is intended to be standard for use in controlling the flow of wastewater, sludges, water, air or chemicals, depending on the applications.

1.07 MAINTENANCE

A. Special Tools

1. Special tools, if required for normal operation and maintenance, shall be supplied with the equipment in accordance with Section 01170.

PART 2 PRODUCTS

2.01 MATERIALS AND EQUIPMENT

A. General

1. All valves and appurtenances shall be of the size shown on the Drawings and as far as possible all equipment of the same type shall be from one manufacturer.

2. All valves and appurtenances shall have the name of the maker, flow directional arrows and the working pressure for which they are designed cast in raised letters upon some appropriate part of the body.

3. Except as otherwise shown on the Drawings or specified herein, all valves with operators located 7-ft or more above the operating floor shall be provided with chain wheel operators complete with chain guides and galvanized steel chain. Handwheel extensions shall be supplied for valve operators in difficult to reach applications.

4. Insofar as possible, all valves shall open counter clockwise.

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## 2.02 VALVES AND APPURTENANCES

A. Gate Valves

1. Gate valves 2-1/2-in in diameter and smaller in size, shall have flanged, screwed, or solder ends as required; and shall be bronze, solid wedge, rising-stem-type gate valves such as Fig. 47 and 48 by Jenkins Bros. or equal products by Crane; Fairbanks or Kennedy Valve Mfg. Co.

2. Gate valves 3-in and larger in size, unless otherwise specified or approved, shall be iron body, bronze mounted, solid wedge gate valves with flanged ends and conforming to the AWWA C500, insofar as applicable and in addition to the following requirements:

   a. Valves shall be outside screw and yoke type with rising stem.

   b. Face to face dimension shall conform to USA Standard Face to Face and End to End Dimensions of Ferrous Valves, (USAS B16.10) for 125 lb cast-iron valves.

   c. Bronze gate rings shall be fitted into grooves of dovetail or similar shape in the gates. For grooves or other shapes, the rings shall be firmly attached to the gates with bronze rivets.

   d. Handwheels shall turn counterclockwise to open the valves. Handwheels shall be of ample size and shall have an arrow and the word OPEN cast thereon to indicate the direction of opening.

   e. Stuffing box follower bolts shall be of steel and the nuts shall be of bronze.

   f. The design of the valves shall permit packing the valves without undue leakage while they are wide open and in service.

   g. O-ring stuffing boxes may be used.

   h. Gate valves shall be by Val-Matic, Dezurik, or approved equal.

B. Plug Valves

1. Plug valves shall be of the offset disc type 1/4 turn, non lubricated, eccentric type with resilient faced plug, serviceable (repacked) under full line pressure and capable of sealing in both directions at the rated pressure.

2. The disc shall be completely out of the flow path when open. Valves 4 in to 20 in shall have a minimum port area of 85 percent and valves 24 in and larger shall have a minimum port area of 75 percent when measured by the percent cross sectional area of equivalent size Schedule 40 steel pipe. Plug valves shall be as manufactured by Valmatic, DeZurick or equal.

3. Valves shall be rated at 175 psi W.O.G. (Water, Oil, Gas) working pressure (minimum). At the above rated minimum working pressure, the valves shall be certified by the manufacturer as permitting zero leakage for a period of at least 1/2 hour with pressure

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applied in either direction. At the direction of the Engineer, the valve manufacturer may be requested to perform a valve seat leakage test, witnessed by the Engineer to prove compliance with this Section.

4. Valve bodies shall be of cast iron, 30,000 psi tensile strength, ASTM A126, Class B and of the top entry, bolted bonnet design, cast with integral flanges conforming to ANSI B16.1 Class 125 dimensions. All exposed bolts, nuts, and washers shall be zinc or cadmium plated, except for buried or submerged valves, which shall have Type 304 stainless steel hardware.

5. The plug shall be of one-piece construction and made of ASTM A126 Class B cast iron with a resilient facing per ASTM D2000-BG and ANSI/AWWA C504 requirements.

6. The valve seating surface shall provide full 360 degree seating by contact of a resilient seating material on the disc mating with welded in high nickel content overlay or a thermo setting epoxy seating surface in the body. The seating design shall be resilient and of the continuous interface type having consistent opening and closing torques and shall be non-jamming in the closed position. If the thermosetting epoxy seat is provided, then the resilient seating surface on the disc shall be of Buna N, either applied to the entire disc, or a ring clamped to the disc by an 18 8 stainless steel clamp ring with self locking 18 8 stainless steel screws. The seat ring shall be replaceable without removing the valve from the line.

7. All valves 8 in and larger shall be equipped with handwheel actuators. Handwheel actuators shall be of the geared or travelling nut type. All actuators shall have enclosed and sealed housings to allow the reduction mechanism to operate in a lubricant. Seals shall be provided on all shafts to prevent the entry of dirt and water into the housing. All shaft bearings shall be furnished with permanently lubricated bronze bearing bushings. Actuator shall clearly indicate valve position and an adjustable stop shall be provided. Hardware on actuators shall be of the same materials as the valves.

8. Each valve 6 in and smaller shall be provided with its own latch lock lever. Provide adjustable limit stops for both opening and closing and a clearly marked position indicator.

9. Where required on the Drawings, furnish position indicating switches on valves. Switches shall be single pole, double throw, at either limit of open or close, or both limits as shown. Switches shall be enclosed in a NEMA 4 enclosure, and contacts shall be rated 10 Amps at 120 VAC.

10. All plug valves shall be installed so that the direction of flow through the valve is in accordance with the manufacturer's recommendations.

C. Check Valves

1. Check valves for ductile iron pipelines shall be lever and weight swing type and shall meet the material requirements of AWWA C508. Check valves shall be SWC Series by Crispin Valve of Berwick, Pennsylvania, Series 8001 by Henry Pratt Company of Aurora, IL, or equal. Disc type check valves such as Swing-Flex or Surgebuster by Val-Matic will NOT be considered as equal.

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2. The valves shall be iron body, bronze mounted, single disc, 150 psi working water pressure, non-shock and hydrostatically tested at 300 psi. Ends shall be 125 lb ANSI B16.1 flanges.

   a. When there is no flow through the line the disc shall hang lightly against its seat in practically a vertical position. When open, the disc shall swing clear of the waterway.

   b. Check valves shall have bronze seat and body rings, extended bronze hinge pins and bronze nuts on the bolts of bolted covers.

   c. Valves shall be so constructed that disc and body seat may easily be removed and replaced without removing the valve from the line. Valves shall be fitted with an extended hinge arm with outside lever and weight.

3. Check valves 2 in and smaller for installation in copper and steel pipes shall be bronze, swing type, 125 lb WSP with solder or screwed ends.

4. Check valves for PVC pipe shall be of PVC Type 1, Series BC with socket or flanged ends as required. Valve bodies shall be union type. PVC ball check valves shall be as manufactured by Celanese Piping Systems, Inc.; Wallace and Tiernan Inc. or equal.

D. Ball Valves

1. Ball valves for PVC pipe shall be of Schedule 80 PVC with socket or flanged ends as required. Valve bodies shall be double union type. PVC ball valves shall be as manufactured by Georg Fischer, or equal. All valves shall be mounted in such a position that valve position indicators are plainly visible when standing on the floor.

E. Globe Valves

1. Valves for copper plant air and water lines shall have threaded or solder ends, bronze body, renewable composition disc, 300 lb cold water non-shock working pressure, Jenkins Fig. 106A or 1200. Valves shall open left or counterclockwise. As far as possible, all globe valves shall be from one manufacturer. Valves shall be mounted as indicated on the Drawings or as directed by the Engineer.

F. Butterfly Valves for Air Service

1. Butterfly valves and operators for low pressure air piping shall conform to the AWWA C504, except as specified specified herein. Valves shall have a minimum 150 psi pressure rating and be equal to those manufactured by Henry Pratt, M&H, or DeZurik valve companies.

2. Butterfly valves shall be flanged end with face to face dimensions in accordance with Table 2 of above mentioned AWWA standards for short-body valve, or wafer type.

3. Valve seats shall be full resilient seats retained in the body or on the disc edge in accordance with Section 8 of the above mentioned AWWA standards. If the resilient seat is in the body, the disc shall be of cast ni-resist conforming to ASTM A436 Type 1 with the periphery machined to a smooth spherical surface. If the resilient seat is mounted on

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the disc edge it shall be held in place by a one-piece Type 304 stainless steel retaining ring and stainless Nylock screws, the disc shall be of ASTM A48, Class 40 cast iron and a mating Type 304 stainless steel ring shall be installed in the valve body. Resilient seats shall be Hycar or equal for water service and Nordel or equal for air service. Resilient seats in valves for air service shall be mounted in the body only.

4. The valve body shall be constructed of close grain cast iron per ASTM A126, Class B with integrally cast hubs for shaft bearing housings of the through boss-type. Permanently self-lubricating body bushings shall be provided and shall be sized to withstand bearing loads. Stuffing box of liberal dimensions shall be provided at the operator end of the vane shaft, arranged so that the packing can be replaced by removing the bronze follower without removing the operator. Packing shall be of the Chevron type as manufactured by Garlock Packing Company. A sealing element utilizing O-rings shall also be acceptable.

5. The valve shaft shall be of Type 304 stainless steel and designed for both torsional and shearing stresses when the valve is operated under its greatest dynamic or seating torque.

6. In general, the butterfly valve operators shall conform to the requirements of Section 3.8 of AWWA C504, insofar as applicable and as specified herein.

7. Gearing for the operators where required shall be totally enclosed in a gear case in accordance with Section 3.8.3 of AWWA C504 standard.

8. Unless otherwise indicated, valves shall be furnished with manual operators. The manual operators shall conform to Section 3.8.1 of AWWA C504 standard, insofar as applicable. Valves shall have handwheel or lever operators and open left, or counterclockwise. Operators shall have indicators to show position of the valve disc. Operators shall be rigidly attached to the valve body.

G. Solenoid Valves

1. Solenoid valves shall be packless piston type direct acting, 2-way or 3-way, valves and shall be ASCO Valve Red Hat by Automatic Switch Co.; Atkomatic Valve Co., or equal for air and water service.

2. Valves on the water lines for the RAS/WAS pump cooling jackets shall be of the normally open type. All other valves shall be of the normally closed type.

3. Valves shall have forged brass bodies, NPT end connections of the size shown on the Drawings, 300 or 400 series stainless steel internal parts, and Buna N or Ethylene Propylene valve seats. Valves shall have a 150 psig (minimum) safe working pressure and zero minimum operating pressure differential. Connections to be threaded.

4. Except as otherwise specified herein, valves shall have NEMA 4 solenoid enclosures, shall be suitable for operation on a 120 Volt, single phase, 60 Hz power supply and shall be provided with a continuous duty Class F coil and a manual operator.

5. Valves located in hazardous areas, as noted on the Drawings, shall be furnished with explosion proof enclosures suitable for Class I, Division I, Group D locations.

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6. Furnish a control manifold system for the air actuated valves for the lime system. The manifold system shall consist of six 3-way solenoid valves, connected to a common inlet manifold and to the individual air actuators as shown on the Drawings. In the de-energized position, the solenoid valves shall close the supply line and vent to atmosphere. Furnish valves, inlet manifold and air supply connections and electric connections to each solenoid wired to a terminal strip enclosed within a NEMA 4 enclosure conforming to all applicable provisions of Division 16.

H. Unions

1. Unions screwed or flanged shall be provided where indicated and in the following locations even if not indicated.

   a. In long runs of piping to permit convenient disassembly for alterations or repairs.

   b. In by-passes around equipment.

   c. In connections to tanks, pumps and other equipment between the shut-off valve and the equipment.

   d. In connections on both sides of traps, controls and automatic control valves.

I. Flexible Connections

1. Flexible connectors shall be expansion/vibration joints of the single arch type of butyl rubber construction with carcass of high grade woven cotton or suitable synthetic fiber and individual solid steel ring reinforcement. Soft rubber fillers shall be integrally cured into the arches to provide a smooth flow path to prevent settling of material into the arch. Joints shall be constructed to pipeline size and to meet working pressures and corrosive conditions similar to the line where installed. Joints shall have full faced fabric reinforced butyl flanges integral with the body.

2. Split steel or ductile iron back-up rings shall be provided to ensure a good joint. Rings shall be designed for mating with ANSI Standard minimum 150 lb flanges. All joints shall be finish coated with Hypalon or equal paint.

3. Expansion/vibration joints shall be furnished with control (harness) units. Harness units shall consist of minimum two drilled plates, stretcher bolts, and rubber washers backed by metal washers. The stretcher bolts shall prevent over-elongation of the joint. Extra nuts shall be provided on the stretcher bolts on the inside of the plate to prevent overcompression. All nuts, bolts and plates shall be galvanized.

4. The manufacturer of the expansion joints shall be a member of the Rubber Expansion Joint Division of the Fluid Sealing Association. Expansion joints shall be Style 1025 filled arch by General Rubber Corp., South Hackensack, NJ or similar products of Mercer Rubber; Goodall Rubber; Garloc; Proco Products Inc., Stockton, CA or equal.

5. In addition to other locations shown on the Drawings, expansion joints shall be utilized in all exposed piping, within 1-ft of a building expansion joint, and on the suction and discharge side of all rotating machinery, as close to the unit as possible.

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J. Plugs and Caps

1. Provide standard plug or cap as required for testing; plugs, caps suitable for permanent service.

2. Plug or cap or otherwise cover all piping work in progress.

K. Miscellaneous Adaptors

1. Between different types of pipe and/or fittings special adapters may be required to provide proper connection. Some of these may be indicated on the Drawings or specified with individual types of pipe or equipment. However, it is the Contractor's responsibility to ensure proper connection between various types of pipe, to structures and between pipe and valves, gates, fittings and other appurtenances. Provide all adapters as required, whether specifically noted or not.

2. As required, these adapters shall be suitable for direct bury, with proper dielectric insulation and as a minimum, if metallic (not stainless steel or galvanized), with two coats of Coal Tar Epoxy.

L. Vents and Drains

1. 1/2-in vents shall be provided at the high point in each system. Vent connections may be tapped, provided the tap will accept three full threads on the bronze nipple.

2. 1-1/2-in drains shall be provided to permit drainage of each system located on the invert of the blind flange; provide hose-end valve.

M. Cleanouts

1. Interior flush floor cleanouts shall consist of a coated cast iron ferrule, a tapered threaded bronze cleanout plug, adjustable housing and a scoriated round cast iron tractor cover with bronze top. Interior flush floor cleanouts shall be Type No. 56056 by Josam Manufacturing Co., Michigan City, IN, similar models by Tyler, or equal.

2. Exterior cleanouts shall consist of a coated cast iron ferrule with cut-off sections, a tapered threaded bronze cleanout plug, Josam 58486 or equal, with a heavy round coated cast iron access frame with anchor flanges and a gasketed cover, Josam Type No. 58680, similar models by Tyler or equal. Exterior cleanouts shall be installed as noted on the Drawings.

3. Cleanouts shall be located where shown on the Drawings.

4. Cleanout connections to 6-in cast iron bell and spigot soil pipe and cleanout connections to 6-in ductile iron bell and spigot pipe shall be caulked.

N. Yard and Post Hydrants

1. Yard hydrants shall be 2-1/8-in Valve Post Type A-24059 by Mueller Company, Decatur, IL or equal. Yard hydrants shall have two 1-1/2-in hose nozzles and 3-in mechanical joint inlet connections. Operating nuts shall be standard AWWA 2-in square and caps shall

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have attachment chains. Two operating wrenches (Type A-24089) of suitable size shall be furnished to operate all yard hydrants. Each hydrant shall have one of the two 1-1/2-in hose nozzles fitted with a special adapter fittings to reduce the nozzle to 3/4-in male hose connections.

2. Post hydrants shall be Eclipse No. 2 as manufactured by John C. Kupferle Foundry Company of St. Louis, Mo or approved equal. Hydrants shall be self draining, non-freezing, compression type with 2-3/16" main valve opening. Inlet connection shall be 2" FIP. Outlet shall be 2" NST. Hydrants shall have a 3" ductile iron pipe riser with a cast iron stock top and non-turning operating rod. Principal interior operating parts shall be brass and be removable without excavating the hydrant. Hydrants shall be set in 4 cubic feet of crushed stone to allow for proper drainage of the hydrant.

O. Corporation Cocks

1. Corporation stops shall be of bronze or brass and shall be designed and manufactured in accordance with AWWA C800, except as modified herein. Corporation stops shall have Mueller inlet threads except that corporation stops for use with service clamps shall have IPS threads. Where corporation stops are used with plastic pipe, a brass companion flange shall be provided on the outlet of each corporation stop.

P. Diaphragm Seals

1. Diaphragm seals shall be installed where shown on the Drawings, to protect pressure gauges and pressure switches used to monitor pressures on sludge and air lines. The diaphragm shall be "thread attached" to both piping and pressure switches or gauges. Diaphragm seals shall be constructed of cadmium plated carbon steel, except for the lower housing which shall be specifically chosen according to the fluid type and pressure being monitored. Diaphragm seals shall have a flushing connecting and be Type SG by Mansfield and Green; Ashcroft, or equal.

2. Diaphragm seals for chemical piping pressure gauges shall be equal to Series 30 threaded-end (p to 1-in diameter piping) or Series 40 wafer flange (1-1/2-in to 2-in piping) as manufactured by Red Valve. Body shall be PVC or stainless steel with PVC end caps, and diaphragms shall be Hypalon.

Q. Service Clamps

1. Service Clamps shall have malleable or ductile iron bodies which extend at least 160 degrees around the circumference of the pipe and shall have neoprene gaskets cemented to the saddle body. Bodies shall be tapped for IPS. Clamps with tap sizes 1-in and smaller shall be of the single strap design. Clamps with tap sizes larger than 1-in shall be of the double strap design.

2. Service clamps shall be Style 91 or 291 by Dresser Industries Inc., Type 311 or 313 by Smith-Blair, Inc., or equal.

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R. Dielectric Connectors

1. Dielectric pipe fittings/insulators and unions shall be used to prevent galvanic action wherever valves or piping of dissimilar metals connect. This shall be particularly the case for copper, brass, stainless steel and bronze piping connecting to cast iron or steel piping systems.

2. Dielectric unions shall be used for 2-in and smaller connections. Steel union nuts shall meet ASTM A575 requirements. The steel or ductile iron connection end shall have a steel body and shall have accurately machined taper tapped pipe threads in accordance with ASME B2.1. The copper connection end shall be a copper solder joint that meets requirements of ASTM B88. Dielectric unions shall be rated for at least 250 psi at 210 degrees F.

3. Dielectric flange unions shall be used for connections 2-1/2-in and larger. Cast iron flanges shall meet ASTM A126; the copper solder end shall meet ASTM B62 and the pipe thread shall meet ASME B2.1. Dielectric flange unions shall be rated for at least 175 psi at 210 degrees F.

4. Dielectric unions and flange unions shall be as manufactured by Epco Inc., Cleveland, OH or equal.

5. Flange insulating kits shall be as acceptable to the Engineer, as manufactured by PSI or equal.

6. Insulated sleeve couplings and flange adaptors shall be similar to those units as specified elsewhere.

S. Combination Air Valves

1. This Section applies to all air release, air/vacuum, hydraulically operated air/vacuum valves, vacuum relief, combination air and air/vacuum or vacuum relief or similar valves.

2. Valves shall be supplied with shutoff gate or ball valves with operator handle or lever removed. Valves shall be properly vented and piped to drain.

3. Attention is directed to the requirement that valve's pressure rating be at least equal to the attached pipe's rating.

4. Valves shall be special non-clean water type, by A.R.I. or approved equal.

5. Air/vacuum function of the valves shall be a slow-venting type, suitable for performance during a hydraulic transient.

6. The valves shall be of the special sewage type. The valve body and all metal components of the valve shall be Type 316 stainless steel. The valve float shall be constructed of polycarbonate and Type 316 stainless steel. A valved outlet with hose connections for flushing water connection shall be provided.

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T. Mud Valves

1. Mud valves shall be non-rising stem type, with Type 316 stainless steel body. The stem, stem nut, stop collar, disc ring shall be Type 316 stainless steel. The seat ring shall be Type 316 stainless steel with a tapered, accurately machined seating face. The plug seat shall be a seamless molded ring of Buna-N tapered to accurately mate with the seat. Bolts and nuts shall be Type 316 stainless steel.

2. Valves shall be equipped with Type 316 stainless steel extension stem, stem guides, offset adjustable floor stand and hand wheel as shown on the Drawings. Stop nut and shaft supports (stem guides) shall be provided as recommended by the manufacturer to prevent damage to the valve or shaft.

3. Stem guides shall be of the adjustable wall bracket type, Type 316 stainless steel, with maximum spacing of 10-ft with an L/R ratio less than 200. Extended operating nuts and/or stems shall have universal joints and pin couplings, if longer than 10-ft and a rating of at least five times the maximum operating torque. Stem adaptors shall be provided.

4. Hand wheel shall have cast on it the word "OPEN" and an arrow indicating the direction of operation.

5. All actuators shall be capable of moving the valve from the full open to full close position and in reverse and holding the valve at any position part way between full open or closed.

6. Provide all special adaptors as required to ensure compatibility between valves, appurtenances, and adjacent pipe

7. Mud valves shall be flanged by Waterman, Troy Valve or engineer approved equal.

2.03 SURFACE PREPARATION AND SHOP PRIME PAINTING

A. Interior surfaces of all valves, the exterior surfaces of buried valves and miscellaneous piping appurtenances shall be given a shop finish of an asphalt varnish conforming to Fed Spec TT-V51e for Varnish Asphalt.

B. The exterior surface of various parts of valves, operators, floorstands and miscellaneous piping shall be thoroughly cleaned of all scale, dirt, grease or other foreign matter and thereafter one shop coat of an approved rust-inhibitive primer such as Inertol Primer No. 621 shall be applied in accordance with the instructions of the paint manufacturer and as specified in Section 09901.

C. Ferrous surfaces obviously not to be painted shall be given a shop coat of grease or other suitable rust-resistant coating.

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PART 3 EXECUTION

3.01 INSTALLATION

A. All valves and appurtenances shall be installed in the locations shown, true to alignment and rigidly supported. Any damage to the above items shall be repaired to the satisfaction of the Engineer before they are installed.

B. After installation, all valves and appurtenances shall be tested at least 1 hour at the working pressure corresponding to the class of pipe, unless a different test pressure is specified. If any joint proves to be defective, it shall be repaired to the satisfaction of the Engineer.

C. Install all brackets, extension rods, guides, the various types of operators and appurtenances as shown on the Drawings that are in masonry floors or walls, and install concrete inserts for hangers and supports as soon as forms are erected and before concrete is poured. Before setting these items, check all plans and figures which have a direct bearing on the proper location of these valves and appurtenances during the construction of the structures.

D. All materials shall be carefully inspected for defects in workmanship and materials; all debris and foreign material cleaned out of valve openings, etc; all operating mechanisms operated to check their proper functioning and all nuts and bolts checked for tightness. Valves and other equipment which do not operate easily, or are otherwise defective, shall be repaired or replaced at no additional cost to the Owner.

E. Yard hydrants shall be set at the locations as shown on the Drawings and bedded on a firm foundation. A drainage pit as detailed on the Drawings shall be filled with screened gravel and satisfactorily compacted. During backfilling, additional screened gravel shall be brought up around and 6-in over the drain port. Each hydrant shall be set in true vertical alignment and properly braced. Concrete thrust blocks shall be placed between the back of the hydrant inlet and undisturbed soil at the end of the trench. Minimum bearing area shall be as shown on the Drawings. Felt roofing paper shall be placed around hydrant elbow before placing concrete. CARE SHALL BE TAKEN TO ENSURE THAT CONCRETE DOES NOT PLUG THE DRAIN PORTS. If directed, the hydrant shall be tied to the pipe with suitable rods or clamps, galvanized, painted, or otherwise rustproof treated. Concrete used for backing shall be no leaner than 1 part cement, 2-1/2 parts sand, and 5-1/2 parts stone. Hydrant paint shall be touched up as required after installation.

F. Buried flanged or mechanical joints shall be made with cadmium plated bolts. All exposed bolts and nuts shall be cadmium plated. All exposed bolts and nuts shall be heavily coated with two coats of bituminous paint comparable to Inertol No. 66 Special Heavy.

G. Install spray nozzles on ductile iron piping on the clarifier as shown on the Drawings. Use pipe thread compound on threads. Rotate nozzle to give the correct direction to the fan shaped spray as directed by the Engineer.

3.02 INSPECTION AND TESTING

A. The various pipe lines in which the valves and appurtenances are to be installed are specified to be field tested. During these tests any defective valve or appurtenance shall be adjusted, removed and replaced, or otherwise made acceptable to the Engineer.

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B. Various regulating valves, strainer, or other appurtenances shall be tested to demonstrate their conformance with the specified operational capabilities and any deficiencies shall be corrected or the device replaced or otherwise made acceptable to the Engineer.

END OF SECTION

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SECTION 15101

ELECTRIC OPERATORS FOR GATES AND VALVES

PART 1 GENERAL

1.01 SCOPE OF WORK

A. Section Includes:

1. Electric motor operators for valves as shown on the Drawings, and as specified herein.

2. The words operator and actuator are used interchangeably in this Section and on the Drawings.

1.02 RELATED WORK

A. Training and Facility Startup is included in Section 01465.

B. Operating and Maintenance Data is included in Section 01782.

C. Paint is included in Section 09901, 09902, & 09903.

D. Valves - General Requirements are included in Section 15100.

E. Weir Gates is included in Section 11282.

F. See also the Drawings, especially the following in addition to mechanical, electrical and civil drawings:

Electrical Control Schematic Drawings.

Process and Instrumentation Drawings (P&IDs).

1.02 SYSTEM DESCRIPTION

A. All electric operators for valves shall be of the non-intrusive, digital microprocessor controlled, design employing electronic transducers for monitoring valve position and shaft torque.

B. All operators shall be furnished with a separate pushbutton control station for mounting adjacent to but remotely from the operator.

C. All electric operators furnished shall be of the type required based on the following general characteristics.

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| TYPE # | Open / Close or Modulating operation | Torque range | 90 degree or Multi-turn operation |
|---|---|---|---|
| 1A | Open / Close | Low | 90 degree |
| 1B | Modulating | Low | 90 degree |
| 2A | Open / Close | Medium | 90 degree |
| 2B | Modulating | Medium | 90 degree |
| 3A | Open / Close | High | 90 degree |
| 3B | Modulating | High | 90 degree |
| 4A | Open / Close | High | Multi-turn |
| 4B | Modulating | High | Multi-turn |

D. The torque requirements of the operator shall be as required to operate the valves and / or gates of the sizes and against the heads listed in accordance with AWWA C540 standards.

1.03 SUBMITTALS

A. Submit, in accordance with Section 01300, the following:

1. Technical bulletins descriptive of the proposed operators and all functions and available features.

2. A complete bill of materials for each operator.

3. Certified operator torque sizing calculations detailing as a minimum the following:

   a. Maximum required valve operating torque.

   b. Maximum available operator operating torque.

   c. Torque rating of gearbox.

   d. Sizing criteria.

   e. Name and organization preparing the calculations.

4. Certified factory test results for each operator. Submittals shall include the following as a minimum for each operator:

   a. Test amperes for each phase

   b. Torque production or confirmation of rating

   c. Operator serial number

5. Certified installation drawings showing details of the complete valve and operator assembly including dimensions, weights and installation requirements.

6. Separate electrical and control details for each individual operator showing the following as a minimum (standard catalogue cut sheets which show typical wiring diagrams are not acceptable):

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a. Operator horsepower and power requirements.

b. Control schematics (wiring diagrams) detailing all external interfaces.

c. Conduit access locations

d. Remote mount control station wiring diagrams and physical mounting requirements.

7. Submittals for operators shall be identified with the exact mechanical equipment number as detailed in the Number Valve List and on the Electrical and Instrumentation Drawings.

8. Field service reports for each operator indicating the successful completion of and recording of all field startup and testing data as specified in PART 3 of this Section.

9. Operating and maintenance manuals per Section 01782 and as specified herein.

1.04 QUALITY ASSURANCE

A. The operators and related devices specified under this Section shall be a model that is in current production and has been available and supplied to the United States water and wastewater market for a minimum of 3 years. Such 3 year experience shall include installation of at least 40 operators at a minimum of 4 different installations. Manufacturers unable to document the 3 year United States market minimum requirement shall provide an extended warranty. The manufacturer shall provide a full warranty against defects in workmanship and materials on the complete operator, gearbox and appurtenances for a minimum of 5 years. The extended warranty shall cover both parts and onsite labor and shall not be pro-rated. Acceptable manufacturers are noted with the descriptions of each type 1A, 1B, 2A, etc.) of operator in this Section. Operators shall be as manufactured by Rotork Controls Inc or approved equal.

B. Electric operators for all new valves and gates shall be factory mounted, tested, and adjusted on the valve for which it is supplied. Mounting and testing of the complete valve and operator assembly shall be performed by one of the following:

1. The valve (or gate) manufacturer.

2. The operator manufacturer.

3. An authorized distributor and service facility for the valves (and gates) having at least 5 years experience in the servicing of the equipment furnished.

4. An authorized distributor and service facility for the operator having at least 5 years experience in the servicing of the equipment furnished.

1.05 OPERATING AND MAINTENANCE INSTRUCTIONS

A. Operating and maintenance instructions, for each type of operator, shall be furnished to the Engineer as provided for in Section 01782.

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B. Field startup of all operators shall be performed by a field service engineer of the operator manufacturer. The field service engineer shall be certified by the operator manufacturer and shall have complete knowledge of proper startup, installation, operation and maintenance of the operators furnished.

C. See Table at end of this Section for additional details.

1.06 OPERATOR TORQUE SIZING

A. The operator manufacturer shall supply the Engineer an affidavit of compliance for each operator and gearbox indicating that the complete operator and gearbox assembly complies with the applicable provisions of the AWWA C504 and C540 and the requirements of this specification regarding torque sizing.

B. The rated torque capability of each operator assembly shall be at least 150 percent of the valve's maximum seating, un-seating, and dynamic torque. For modulation service valves, the rated torque capacity of the operator assembly at the number of starts per hour shall be at least 150 percent of the valve's required torque. The valve's required torque shall be provided by the valve manufacturer and shall be defined as the torque required to seat, unseat and rigidly hold the valve in any intermediate position and under the differential pressures and pipeline velocities shown. Unless the valve is required to isolate flow in both directions, the valve's required torque shall be for installation in the preferred direction only.

1.07 MAINTENANCE

A. Spare Parts

1. Furnish the standard set of spare parts required for normal operation and maintenance as recommended by the operator manufacturer in accordance with Section 15050.

2. In addition, the following spares shall be furnished:

a. One complete electric operator microprocessor controller circuit board for each 20 operators furnished on the project (minimum of 1 controller board of each different type) using that circuit board.

1.08 GENERAL, ELECTRICAL, CONTROL AND INSTRUMENTATION RESPONSIBILITIES

A. The quality and construction of electrical, instrumentation, and control equipment to be furnished under this Section shall conform Division 16, in its entirety; and any specific requirements included within this Section.

PART 2 PRODUCTS

2.01 GENERAL OPERATOR REQUIREMENTS

A. Unless otherwise noted, all operators shall have the following general features in addition to the special features required under the specific "OPERATOR TYPE" paragraphs.

B. All operators shall include, but are not limited to, high torque reversible motor, reduction gearing, manual operation handwheel, motor power controller (starter), digital microprocessor controller, electronic position monitoring and electronic torque sensing all as a self-contained unit that fully conforms to AWWA C540.

C. Unless noted otherwise, all operators shall utilize 3 phase, reversible, squirrel cage induction motors. Motor insulation shall be Class F or H suitable for 1200 starts per hour operation. Motor bearings shall be of the permanently sealed type.

D. All operators shall incorporate multiple reduction gearing consisting of self-locking worm and motor spur gear drives suitable for maintaining valve position in the event of electric power failure. All gearing shall be grease or oil bath lubricated and suitable for operation in any installation position. All rotating components shall be supported on heavy duty anti-friction bearings. Gearing systems that rely on mechanical brakes or other mechanisms other than the self-locking worm gear method to maintain valve position are unacceptable.

E. Reduction gearing and motor speed for valve operators shall be selected by the operator manufacturer to provide approximately a 60 second full stroke operating time per 12-in of valve size unless noted otherwise on the Drawings or Specifications or recommended by the valve manufacturer.

F. All external hardware and anchor bolts shall be ASTM A276, Type 304 stainless steel.

G. The operator housing shall be of high strength cast iron or cast aluminum construction designed to meet NEMA 4X and 6P waterproof and submersible requirements. All field wiring terminations shall be made in a separate watertight compartment that prevents water from entering the remainder of the operator enclosure.

H. The operator shall be suitable for operation in ambient temperatures from 40 to 120 degrees F.

I. A handwheel shall be provided for manual operation. The manual handwheel shall not rotate during motor operation. A motor failure shall not prevent manual handwheel operation. A positive mechanical declutching mechanism shall be provided to switch from electric to manual operation. Manual operation of the declutching mechanism shall allow handwheel operation, however the unit shall automatically return to electric operation whenever the operator motor is energized. Positive mechanical end of travel stops shall be provided to prevent over travel while using the handwheel. The maximum rim pull force required for manual operation using handwheels or chain wheels shall be 40 pounds.

J. Each operator shall be provided with an externally mounted mechanical valve position indicator.

K. An integrally mounted and fused control power transformer shall be provided to power the operator controls at a maximum of 120 VAC.

L. A space heater shall be provided in the operator housing designed to prevent condensation and moisture accumulation within the microprocessor portion of the operator enclosure.

M. All valve operators shall be furnished with control stations suitable for mounting remotely from, but, in the vicinity of the operator. Pushbutton stations integrally mounted on the

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operator may be retained; however, they do not meet the remote mount requirements of this Section and shall be supplemented with a remote mount control station as specified. The exact requirements for the control station components shall be as detailed on the Instrumentation P&IDs and Electrical Control Schematic Drawings. In general the remote mount control station shall include a LOCAL - OFF - REMOTE selector switch, OPEN - STOP - CLOSE pushbuttons and OPEN - CLOSE indicating lights. Control station operators shall be heavy duty full-size devices mounted in a cast iron, cast aluminum, or stainless steel NEMA 4X enclosure suitable for wall mounting. The LOCAL - OFF - REMOTE selector switch shall have auxiliary contacts for remote indication of switch position. The LOCAL - OFF - REMOTE selector switch shall have provisions for padlocking in the OFF position. Pushbuttons and indicator lights shall be Allen-Bradley Bulletin 800H, or equal. Indicator lights shall be LED type. Control stations shall be furnished by the operator manufacturer.

N. All operators shall be furnished with contacts for remote control and position indication. Position monitoring shall be electronically sensed and shall not rely on mechanical limit switches. Contacts shall be configurable through the operator microprocessor to allow flexibility of adjustment. Position contacts shall be furnished in the quantity as shown on the Instrumentation P&IDs and Electrical Control Schematic Drawings, however as a minimum four open position and four close position single pole, single throw contacts shall be provided.

O. The operator shall be equipped with torque sensing responsive to overloads encountered in either the opening or closing direction. Torque monitoring shall be electronically sensed and shall not rely on mechanical torque switches. Torque sensing switches shall be independently adjustable for both the opening and closing directions. The torque protection feature shall operate during the complete valve cycle. The torque switch shall be wired to disengage the operator motor in the event excessive loads are encountered during travel and/or for torque seating of valves as recommended by the manufacturer.

P. Starters shall provide electrical overload protection of the motor by sensing high current draw or high motor winding temperature. Overloads shall be the automatic reset type.

Q. Unless noted otherwise all operators shall be suitable for connection to a 480 VAC, 3 Phase power source. Confirm and coordinate power supply voltage with the Specifications and Drawings prior to submittals.

R. The control package shall incorporate a digital microprocessor controller. The control unit shall include the following features as a minimum:

1. A phase discriminator shall ensure proper rotation direction of the motor regardless of the connection of the power phase leads to the operator.

2. All settings of the microprocessor shall be password protected.

3. All adjustments of the microprocessor shall be configurable by both portable handheld programmer and from a personal computer.

4. Configuration adjustments from both the portable programmer and the personal computer shall be made without opening the operator enclosure via optical (or similar) data coupling technology.

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5. Handheld programmer: A minimum of 1 portable programmer shall be furnished for each 10 operators provided on the project.

6. The module is required to allow operator configuration and diagnostics from a personal computer shall be furnished by the operator manufacturer. (The personal computer shall be furnished by the Owner.) The configuration software shall allow setup, adjustment and monitoring of all parameters in the operator microprocessor controller. The software shall be furnished on CD complete with an executed licensing agreement for unlimited Owner users.

7. The operator shall have an integral LED display that includes indication of the following data as a minimum:

   a. Valve position in percent of open in 1 percent increments

   b. Malfunction details (diagnostics)

   c. Full open, full close and in transition LED indictors

8. Four output contacts configurable for position indication.

9. One output contact configured for operator controller switch not in the REMOTE position.

10. The controller shall have provisions for the future addition of Modbus network interface module.

11. The microprocessor shall have an integral data logger that retains information on the last 150 operating cycles. All operations shall be logged and time and date stamped. Data logger information shall be downloadable to a personal computer with the software furnished.

12. The microprocessor shall have an integral memory storage for service notes. The service notes memory shall be accessible by the personal computer configuration and diagnostic software furnished. The service notes information shall be downloadable to a personal computer with the software furnished.

13. Operator mounted position indication LEDs shall be configurable for color and function.

2.02 ELECTRICAL CONTROLS FOR OPEN - CLOSE OPERATORS (TYPE 2A, 3A & 4A)

A. The operator shall contain an integral reversing motor starter suitable for receiving open - stop - close commands in the form of momentary dry contact closures. The operator starter shall cause the valve to move in the appropriate direction until stopped by the operator position switches or stop control (or torque switch for torque seated valves). Starters shall have auxiliary "seal in" contacts as required to implement the control action.

B. Electromechanical starters shall be mechanically and electrically interlocked. Solid state starters shall be designed for minimum susceptibility to power line surges and spikes and shall be tested to 6,000 VAC as specified by IEEE C62.41.

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C. Refer to the Instrumentation P&IDs and Electrical Control Schematic Drawings for additional control package details.

2.03 ELECTRICAL CONTROLS FOR MODULATING OPERATORS (TYPE 2B, 3B & 4B)

A. The operator shall contain an integral position control system. The control system shall be capable of receiving an external 4-20 mA input setpoint signal corresponding to optimum valve position or process control setting and comparing this to an internally generated feedback signal corresponding to valve position to provide the actual deviation signal to the motor controller. The operator shall automatically adjust the position of the operator when the error in the comparison of setpoint to feedback is greater than the deadband of the controller. The deadband shall be preset by the manufacturer but shall be field configurable.

B. The operator control unit shall be digital microprocessor based.

C. The controller shall have a loss of command signal protection. The controller shall be selectable to lock in the last signal or to lock in a preset valve position.

D. The controller shall have a 4-20 mA valve position output signal for remote indication.

E. The operator control unit output shall drive a solid state or electromechanical reversing starter to position the operator motor. Electromechanical contactors shall be mechanically and electrically interlocked. Solid state starters shall be designed for minimum susceptibility to power line surges and spikes and shall be tested to 6,000 VAC as specified by IEEE C62.41.

F. The starter and control unit shall be rated for continuous modulating applications of a minimum of 1200 starts per hour.

G. The LOCAL - OFF - REMOTE switch shall simultaneously select both the operating mode and signal source. In the REMOTE position, the controller shall position the valve based on the remotely generated 4 - 20 mA signal. In the LOCAL position, the controls shall position the valve based on the locally mounted OPEN - STOP - CLOSE pushbutton station.

H. Refer to the Instrumentation P&IDs and Electrical Control Schematic Drawings for additional control package details.

2.04 TYPE 1A OPERATOR (LOW TORQUE – OPEN/CLOSE -QUARTER TURN VALVE TYPE)

A. Operators shall comply with all requirements of Paragraph 2.01 except as modified in this Section.

B. The controller is not required to be a microprocessor based.

C. Operators shall have a published running torque range from approximately 100 pound -inches to 1000 pound - inches.

D. Unless indicated otherwise, the motor shall be a 480Volt three phase split- capacitor type with integral auto - reset overload protection and class B insulation suitable for a minimum of 360 starts per hour.

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E. The unit shall have controls in accordance with Paragraph 2.02 Electrical Controls for Open - Close Operators.

F. Each operator shall be furnished with a custom fabricated control enclosure which shall be factory assembled and wired to the operator. The control enclosure shall contain a motor power disconnect switch, open and close starter as detailed on the electrical drawings. The power disconnect shall be a horsepower rated fractional horsepower motor starter switch. The starters shall have replaceable contacts rated for the motor starting duty of the operator. The control enclosure shall be rated NEMA 4X.

G. Auxiliary contacts that are required to implement the control action shall be provided by the operator manufacturer and may be either shaft driven limit switches or auxiliary control relay contacts. Control relays shall be housed in the operator housing or in an auxiliary equipment enclosure. If an auxiliary enclosure is required for housing control relays, it shall be factory mounted and wired to the operator enclosure. Auxiliary enclosures may be fabricated of sheet steel but shall have the same NEMA rating as the operator housing.

H. Torque switches need not have a field calibration indication mechanism if they are factory adjusted and sealed.

I. Manual operation handwheels need not have a separate declutching lever if the operator incorporates alternative design features to prevent injury to personnel during manual operation.

J. Electric operators used on Chemtrol plastic valves shall be NIBCO Series 300, or prior approved equal.

K. Electric operators used on all other valve types shall be by Rotork Controls Inc. or approved equal.

2.05 TYPE 1B OPERATORS (LOW TORQUE – MODULATING - QUARTER TURN VALVE TYPE)

A. Operators shall comply with all requirements of Paragraph 2.01 except as modified in this Section.

B. The controller is not required to be a microprocessor based.

C. Operators shall have a published running torque range from approximately 100 pound -inches to 1000 pound -inches.

D. Unless indicated otherwise, the motor shall be a 480 Volt three phase split-capacitor type with integral auto - reset overload protection and Class B insulation suitable for a minimum of 1200 starts per hour.

E. The operator shall have the following modulating controls:

1. The operator shall contain an integral position control system. The control system shall be capable of receiving an external 4-20 mA input setpoint signal corresponding to optimum valve position or process control setting and comparing this to an internally generated

feedback signal corresponding to valve position to provide the actual deviation signal to the motor controller. The operator shall automatically adjust the position of the operator when the error in the comparison of setpoint to feedback is greater than the deadband of the controller. The deadband shall be factory set but shall be field adjustable.

2. The operator control unit shall be solid state.

3. The control shall contain a loss of command signal protection selectable to lock in last or lock in preset valve position.

4. The control shall contain a 4-20 mA valve position output signal for remote indication.

5. The operator control unit output shall drive a solid state, reversing starter to position the operator motor. Solid state starters shall be designed for minimum susceptibility to power line surges and spikes and shall be tested to 6,000 VAC as specified by IEEE C62.41.

6. The starter and control unit shall be rated for continuous modulating applications of a minimum of 1200 starts per hour.

7. The LOCAL - OFF - REMOTE switch shall simultaneously select both the operating mode and signal source. In the REMOTE position, the controller shall position the valve based on the remotely generated 4-20 mA signal. In the LOCAL position, the controls shall position the valve based on the locally mounted OPEN - STOP - CLOSE pushbutton station.

8. Refer to the Instrumentation P&IDs and Electrical Control Schematic Drawings for additional control details.

F. Each operator shall be furnished with a custom fabricated control enclosure which shall be factory assembled and wired to the operator. The control enclosure shall contain a motor power disconnect switch, position control system, open and close starter as detailed on the electrical drawings. The power disconnect shall be a horsepower rated fractional horsepower motor starter switch. The starter shall have replaceable contacts rated for the motor starting duty of the operator. The control enclosure shall be rated NEMA 4X.

G. Auxiliary contacts that are required to implement the control action shall be provided by the operator manufacturer and may be either shaft driven limit switches or auxiliary control relay contacts. Control relays shall be housed in the operator housing or in an auxiliary equipment enclosure. If an auxiliary enclosure is required for housing control relays, it shall be factory mounted and wired to the operator enclosure. Auxiliary enclosures may be fabricated of sheet steel but shall have the same NEMA rating as the operator housing.

H. Torque switches need not have a field calibration indication mechanism if they are factory adjusted and sealed.

I. Manual operation handwheels need not have a separate declutching lever if the operator incorporates alternative design features to prevent injury to personnel during manual operation.

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J. Electric operators used on Chemtrol plastic valves shall be NIBCO Series 300, or prior approved equal.

K. Electric operators used on all other valve types shall be by Rotork Controls Inc or approved equal.

2.06 TYPE 2A OPERATOR (MEDIUM TORQUE - OPEN/CLOSE - QUARTER TURN VALVE TYPE)

A. Operators shall comply with all requirements of Paragraph 2.01 except as modified in this Section.

B. Operators shall have a published running torque range from approximately 200 foot-pounds to 1200 foot-pounds.

C. The unit shall have controls in accordance with Paragraph 2.02 Electrical Controls for Open - Close Operators.

D. Electric operators shall be Rotork series IQ or prior approved equal.

2.07 TYPE 2B OPERATOR (MEDIUM TORQUE - MODULATING - QUARTER TURN VALVE TYPE)

A. Operators shall comply with all requirements of Paragraph 2.01 except as modified in this Section.

B. Operators shall have a published running torque range from approximately 200 foot-pounds to 1200 foot-pounds.

C. The unit shall have controls in accordance with Paragraph 2.03.

D. Electric operators shall be Rotork series IQ or prior approved equal.

2.08 TYPE 3A OPERATOR (HIGH TORQUE - OPEN/CLOSE - QUARTER TURN VALVE TYPE)

A. Operators shall comply with all requirements of Paragraph 2.01 except as modified in this Section.

B. Operators shall have a published running torque range from approximately 100 foot-pounds to 20,000 foot-pounds.

C. The operator shall be mounted to a quarter turn worm gear box suitable for direct mounting on the valve stem. The gear box shall comply with AWWA C540.

D. The unit shall have controls in accordance with Paragraph 2.02.

E. Electric operators shall be Rotork series IQ or prior approved equal.

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2.09 TYPE 3B OPERATOR (HIGH TORQUE - MODULATING - QUARTER TURN VALVE TYPE)

A. Operators shall comply with all requirements of Paragraph 2.01 except as modified in this Section.

B. Operators shall have a published running torque range from approximately 100 foot-pounds to 20,000 foot-pounds.

C. The operator shall be mounted to a quarter turn worm gear box suitable for direct mounting on the valve stem. The gear box shall comply with AWWA C540.

D. The unit shall have controls in accordance with Paragraph 2.03.

E. Electric operators shall be Rotork series IQ or prior approved equal.

2.10 TYPE 4A OPERATOR (HIGH TORQUE - OPEN/CLOSE - MULTI-TURN LARGE GATE TYPE)

A. Operators shall comply with all requirements of Paragraph 2.01 except as modified in this Section.

B. Operators shall have a published running torque range from approximately 100 foot-pounds to 6000 foot-pounds.

C. The operator shall have a stem nut of high tensile bronze or other material, compatible with the stem and suited to the application. The nut arrangement, where possible, shall be of the two-piece type to simplify field replacement. The stem nut for rising stem gates must be capable of being removed from the top of the operator without removing the operator from the gate, disconnecting the electrical wiring, or disassembling any of the gearing within the operator.

D. The unit shall have controls in accordance with Paragraph 2.02.

E. Electric operators shall be Rotork series IQ or prior approved equal.

2.11 OPERATOR MOUNTING BRACKETS

A. When Type 2 or 3 operators are utilized on small valves (4-in and smaller) the operator shall be equipped with separate mounting brackets to support the operator weight independently of the piping and valve system. The brackets shall be provided with a support assembly as shown on the Drawings. The bracket shall be a factory fabricated from 1/4-in carbon steel (minimum) and factory assembled between the operator and the valve. The operator stem and coupling shall be of sufficient length to accommodate the 1/4-in plate.

B. All operator and valve assemblies shall be match marked during mounting with indelible markings to illustrate proper relative orientation and facilitate disassembly and reassembly in the field.

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C. In particular these operator mounting brackets are to be utilized operators on ozone diffusion header and riser valves and ozone generator flow control valves.

D. Operator mounting brackets shall be designed, fabricated and furnished by the operator or valve supplier as identified in PART 1 of this Section. Field fabricated support brackets are not acceptable.

## PART 3 EXECUTION

### 3.01 INSTALLATION

A. All electric operators shall be properly supported, in addition to piping and valve supports, to minimize load on valve and piping system.

B. Operator supports shall allow access to all controls and internal components without removal of operator support.

C. Operators shall be oriented so that the front LED panel is easily accessible for startup and configuration.

### 3.02 COATINGS

A. Operators for valves shall be coated as noted in Section 09901, 09902, & 09903. The manufacturer's factory coating must be compatible with the field coating system specified for the piping associated with the valve.

B. Field painting and coating shall include touch-up work to repair any damage to shop painting or coating.

### 3.03 FACTORY TESTING

A. All operators shall be inspected and tested at the factory by the operator manufacturer. Results of these tests shall be submitted to the Engineer. As a minimum, the manufacturer's tests shall include the data specified in Paragraph 1.03 above.

### 3.04 HANDLING, DELIVERY AND STORAGE

A. Refer to Section 01600 for additional information.

B. Care should be taken in loading, transporting and unloading to prevent injury to the operator. All equipment shall be examined before installation. Equipment that is found to be defective shall not be installed.

### 3.05 FIELD INSPECTION, ADJUSTMENT, STARTUP AND TESTING

A. Field inspection, adjustment, startup and testing shall be in accordance with 01465, in addition to the following requirements.

B. The operator manufacturer's field service engineer shall inspect, adjust, startup and test all operators furnish under this project. Services of a valve field service engineer are not sufficient

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to meet this requirement. Field service shall include the following as a minimum for each operator:

1. Adjust and record the setpoints for all position and torque sensors.
2. Measure and record operator operating voltage and amps during three full operating cycles of the valve.
3. Confirm proper operation of the microprocessor data logger and diagnostic package.
4. Confirm proper operation all field interface signals.
5. Confirm that all conduit openings into the operator are sealed.
6. Confirm that the operator and gearbox are filled with the proper types of lubricant.
7. Readjust valve setpoints a minimum of one additional time for 50 percent of the valves as directed solely by the Engineer to aid in loop tuning and associated work.

D. Submit all field test results to the Engineer.

END OF SECTION

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# SECTION 15140

# PIPE HANGERS AND SUPPORTS

## PART 1 GENERAL

### 1.01 SCOPE OF WORK

A. Furnish all labor, materials, equipment and incidentals and install pipe hangers, supports, concrete inserts and anchor bolts including all metallic hanging and supporting devices for supporting non-buried piping as shown on the Drawings and as specified herein.

### 1.02 RELATED WORK

A. Wind Design Criteria are included in Section 01614

B. Seismic Design Criteria are included in Section 01615

C. Concrete is included in Division 3.

D. Miscellaneous metal is included in Section 05500.

E. Field painting is included in Section 09902.

F. Pipe and fittings are included in Division 15.

G. Valves and appurtenances are included in Section 15100.

### 1.03 SUBMITTALS

A. Submit, in accordance with Section 01300, complete sets of shop drawings of all items to be furnished under this Section. Submittals shall include complete layouts, schedules, location plans and complete total bill of materials for all pipe support systems.

B. Submittals shall include a representative catalog cut for each different type of pipe hanger or support indicating the materials of construction, important dimensions and range of pipe sizes for which that hanger is suitable. Where standard hangers and supports are not suitable, submit detailed drawings showing materials and details of construction for each type of special hanger and support.

C. Submittals shall include complete piping drawings indicating type of hanger and support, location, magnitude of load transmitted to the structure and type of anchor, guide and other pipe supporting appurtenances. Submittals shall use detail numbers as shown on the Drawings to indicate type of support proposed wherever possible.

D. Submit complete design data for pipe support systems to show conformance with this Section.

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1.04 REFERENCE STANDARDS

A. Manufacturer's Standardization Society (MSS)

1. MSS SP-58 - Pipe Hangers and Supports - Materials, Design and Manufacture.

2. MSS SP-69 - Pipe Hangers and Supports - Selection and Application.

B. American Society for Testing and Materials (ASTM)

1. ASTM A36 - Standard Specification for Carbon Structural Steel.

2. ASTM A307 - Standard Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength.

C. American National Standards Institute (ANSI)

1. ANSI B31.1 - Power Piping.

D. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.05 QUALITY ASSURANCE

A. All hangers, supports and appurtenances shall conform to the latest applicable requirements of ANSI B31.1.0, except as supplemented or modified by the requirements of this Section.

B. All hangers, supports and appurtenances shall be of approved standard design where possible and shall be adequate to maintain the supported load in proper position under all operating conditions. The minimum working factor of safety for all supporting equipment, with the exception of springs, shall be five times the ultimate tensile strength of the material, assuming 10-ft of water filled pipe being supported.

C. All pipe and appurtenances connected to equipment shall be supported in such a manner as to prevent any strain being imposed on the equipment. When manufacturers have indicated requirements that piping loads shall not be transmitted to their equipment, submit certification stating that such requirements have been complied with.

1.06 DELIVERY, STORAGE AND HANDLING

A. All supports and hangers shall be crated, delivered and uncrated so as to protect against any damage.

B. All parts shall be properly protected so that no damage or deterioration shall occur during a prolonged delay from the time of shipment until installation is completed.

C. Finished iron or steel surfaces not galvanized or painted shall be properly protected to prevent rust and corrosion.

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PART 2 PRODUCTS

2.01 GENERAL

A. All of the equipment specified herein is intended to support the various types of pipe and piping systems. The details shown on the Drawings are intended to indicate the generally desired methods of support under normal conditions. Develop final details and any details associated with special conditions not already covered to meet the system conditions specified in Division 15.

B. All pipe and tubing shall be supported as required to prevent significant stresses in the pipe or tubing material, valves, fittings, and other pipe appurtenances and to support and secure the pipe in the intended position and alignment. All supports shall be designed to adequately secure the pipe against excessive dislocation due to thermal expansion and contraction, internal flow forces and all probable external forces such as equipment, pipe and personnel contact. Any structural steel members required to brace any piping from excessive dislocation shall conform to the applicable requirements of Section 05500 and shall be furnished and installed under this Section.

C. Hangers and supports shall be spaced in accordance with ANSI B31.1 except that the maximum unsupported span shall not exceed 10-ft unless otherwise specified herein.

D. Where flexible couplings are required at equipment, tanks, etc, the end opposite to the piece of equipment, tank, etc, shall be rigidly supported.

E. All pipe and appurtenances connected to the equipment shall be supported in a manner to prevent any strain from being imposed on the equipment or piping system.

F. All rods, clamps, hangers, inserts, anchor bolts, brackets and components for interior pipe supports shall be furnished with galvanized finish, hot dipped or electro-galvanized coated, except where field welding is required. Interior clamps on plastic pipe shall be plastic coated. Supports for copper pipe shall be copper plated or shall have a 1/16-in plastic coating. All rods, clamps, hangers, inserts, anchor bolts, brackets and components for exterior pipe and pipe within outdoor structures shall be of Type 316 stainless steel.

G. Supports shall be sufficiently close together such that the sag of the pipe is within limits that will permit drainage and avoid excessive bending stresses from concentrated loads between supports.

H. All un-insulated non-metallic piping such as PVC, CPVC, etc, shall be protected from local stress concentrations at each support point. Protection shall be provided by galvanized steel protection shields or other method as approved by the Engineer. Where pipes are bottom supported 180 degrees, arc shields shall be furnished. Where 360 degree arc support is required, such as U bolts, protection shields shall be provided for the entire pipe circumference. Protection shields shall have an 18 gauge minimum thickness, not be less than 12-in in length and be securely fastened to pipe with stainless steel or galvanized metal straps not less than 1/2-in wide.

I. All insulated pipe shall be furnished with a rigid foam insulating saddle at each pipe support location as specified under respective pipe insulation. Provide galvanized protection shields as specified in Paragraph 2.01H above at each location.

J. Where pipe hangers and supports come in contact with copper piping provide protection from galvanic corrosion by; wrapping pipe with 1/16-in thick neoprene sheet material and galvanized protection shield; isolators similar to Anvil, Figure CT-69; or copper plated or PVC coated hangers and supports.

K. Pipe supports shall be provided as follows:

1. Cast iron and ductile iron piping shall be supported at a maximum support spacing of 10-ft with a minimum of one support per pipe section at the joints.

2. Steel and stainless steel piping 2-1/2-in or larger diameter shall be supported at a maximum support spacing of 10-ft with a minimum of one support per pipe section at the joints.

3. Support spacing for steel and stainless steel piping 2-in and smaller diameter and copper tubing shall not exceed 5-ft.

4. Supports for multiple PVC plastic piping shall be continuous wherever possible. Individually supported PVC pipes shall be supported as recommended by the manufacturer except that support-spacing shall not exceed 3-ft.

5. Multiple, suspended, horizontal plastic PVC pipe runs, where possible, shall be supported by ladder type cable trays such as the Husky Ladder by MPHusky; or equal. Ladder shall be of mild steel construction. Rung spacing shall be 12-in. Tray width shall be approximately 6-in for single runs and 12-in for double runs. Ladder type cable trays shall be furnished complete with all hanger rods, rod couplings, concrete inserts, hanger clips, etc, required for a complete support system. Individual plastic pipes shall be secured to the rungs of the cable tray by strap clamps or fasteners similar to MPHusky, Model SCR or equal. Spacing between clamps shall not exceed 9-ft. The cable trays shall provide continuous support along the length of the pipe. Individual clamps, hangers and supports in contact with plastic PVC pipe shall provide firm support but not so firm as to prevent longitudinal movement due to thermal expansion and contraction.

6. All vertical pipes shall be supported at each floor or at intervals of not more than 12-ft by approved pipe collars, clamps, brackets, or wall rests and at all points necessary to insure rigid construction.

7. Pipe supports shall not induce point loadings, but shall distribute pipe loads evenly along the pipe circumference.

8. Supports shall be provided at changes in direction and elsewhere as shown in the Drawings or as specified herein. No piping shall be supported from other piping or from metal stairs, ladders and walkways, unless specifically directed or authorized by the Engineer.

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9. Pipe supports shall be provided to minimize lateral forces through valves, both sides of split type couplings and sleeve type couplings and to minimize all pipe forces on pump housings. Pump housings shall not be utilized to support connecting pipes.

10. Effects of thermal expansion and contraction of the pipe shall be accounted for in the pipe support selection and installation.

L. Unless otherwise specified herein, pipe hangers and supports shall be as manufactured by Anvil International, Portsmouth, NH; Carpenter & Patterson, Inc., Woburn, MA; and Unistrut Northeast, Cambridge, MA or equal. Any reference to a specific figure number of a specific manufacturer is for the purpose of establishing a type and quality of product and shall not be considered as proprietary.

M. Any required pipe supports for which the supports specified in this Section are not applicable shall be fabricated or constructed from standard structural steel shapes, concrete and anchor hardware similar to items previously specified herein and shall be subject to the approval of the Engineer.

N. Anchor bolts shall be equal to Kwik-Bolt 3 as manufactured by the Hilti USA, Tulsa, OK or Wej-it by Wej-it Expansion Products, Inc., Bloomfield, CO. The length of expansion bolts shall be sufficient to place the wedge portion of the bolt a minimum of 1-in behind the steel reinforcement.

## 2.02 SINGLE PIPE HANGERS

A. Single pipes shall be supported by hangers suspended by galvanized steel rods from structural steel members, concrete ceilings and beams, bottom of trapeze hangers and wall mounted steel angle brackets.

B. Hanger rods shall be hot rolled steel, machine threaded and galvanized after fabrication. The strength of the rod shall be based on its root diameter.

C. Except as otherwise specified herein, pipe hangers shall be adjustable clevis type similar to Anvil, Figure No. 65, 260, 300, and 590 as required. Hangers shall be carbon steel with a galvanized finish.

D. Hanger rods shall be attached to concrete structures using concrete inserts similar to Anvil Figures 152 or 282. Inserts shall be malleable iron, or steel with galvanized finish. Beam clamps, C clamps or welded beam attachments shall be used for attaching hanger rods to structural steel members. Where necessary and approved by the Engineer, double expansion shields shall be used for attaching to concrete structures.

E. Where pipes are near walls, beams, columns, etc, and located an excessive distance from ceilings or underside of beams, welded steel wall brackets similar to Anvil, Figure No. 194, 195 or 199 shall be used for hanging pipe. Brackets shall be galvanized. Where single pipes rest on top of bracket pipe supports, attachments shall meet requirements as specified under multiple pipe hangers.

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2.03 MULTIPLE PIPE HANGERS

A. Suspended multiple pipes, running parallel in the same horizontal plane, which are adjacent to each other shall be suspended by trapeze type hangers or wall brackets. Trapeze hangers shall consist of galvanized structural steel channel supported from galvanized threaded rod or attached to concrete walls, columns or structural steel support members as required to meet the intent of this Section. Channel shall be similar to Anvil, Figure 46; Unistrut Series No. P-5500, Power Strut No. PS-1100 or equal. Rods, concrete inserts, "C" clamps, beam clamps, welded beam attachments, and expansion shields shall be as specified in Paragraph 2.02 above.

B. Except as otherwise specified herein pipe anchors used for attaching pipe to trapeze or multiple pipe wall brackets shall be anchor or pipe chairs similar as recommended by the manufacturer. Material of construction shall be galvanized steel. Chair "U" bolts shall be tightened to allow freedom of movement for normal expansion and contraction except where pipe must be anchored to control direction of movement or act as a thrust anchor.

2.04 SINGLE AND MULTIPLE PIPE SUPPORTS

A. Single pipes located in a horizontal plane close to the floor shall be supported by one of the methods as shown on the Drawings and as specified herein.

B. Pipes 3-in in diameter and larger shall be supported by adjustable stanchions similar to Anvil, Figure 264, constructed of galvanized steel. Stanchions shall provide at least 4-in adjustment and be flange mounted to floor.

C. Pipes less than 3-in in diameter shall be held in position by supports fabricated from steel "C" channel, welded post base similar to Unistrut, Figure P2072A and pipe clamps similar to Unistrut, Figures P1109 thru P1126. Where required to assure adequate support, fabricate supports using two vertical members and post bases connected together by horizontal member of sufficient load capacity to support pipe. Wherever possible supports shall be fastened to nearby walls or other structural member to provide horizontal rigidity. More than one pipe may be supported from a common fabricated support. All supports unless specified elsewhere shall be galvanized.

D. Where shown on the Drawings, pipe shall be supported using concrete anchor posts. Pipe shall be securely fastened to concrete anchor posts using suitable metal straps as required and approved by the Engineer.

2.05 WALL SUPPORTED PIPES

A. Single or multiple pipes located adjacent to walls, columns or other structural members, whenever deemed necessary, shall be supported using welded steel wall brackets similar to Anvil Figure 194, 195, and 199; or "C" channel with steel brackets similar to Unistrut pipe clamps. All members shall be securely fastened to wall, column, etc, using double expansion shields or other method as approved by the Engineer. Additional wall bearing plates shall be provided where required.

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B. Pipe shall be attached to supports using methods specified herein to meet the intent of this Section.

C. All supports shall be galvanized.

2.06 BASE ANCHOR SUPPORT

A. Where pipes change direction from horizontal to vertical via a bend, a welded or cast base anchor support shall be installed at the bend to carry the load. The bend anchor shall be fastened to the floor and double expansion shields or other method as approved by the Engineer.

B. Where shown on the Drawings, pipe bends shall be supported using concrete anchor posts. Pipes shall be securely fastened to concrete supports with suitable metal bands as required and approved by the Engineer.

2.07 VERTICAL PIPE SUPPORTS

A. Where vertical pipes are not supported by a Unistrut system as specified in Paragraph 2.08 below, they shall be supported in one of the following methods.

1. For pipes 1/4-in to 2-in in diameter, an extension hanger ring shall be provided with an extension rod and hanger flange. The rod diameter shall be as recommended by the manufacturer for the type of pipe to be supported. The hanger ring shall be galvanized steel or PVC clad depending on the supported pipe. The hanger ring shall be equal to Carpenter & Paterson, Figure No. 81 or 81CT. The anchor flange shall be galvanized malleable iron similar to Carpenter and Patterson, Figure No. 85.

2. For pipes equal to or greater than 1/2-in in diameter extended pipe clamps similar to Carpenter and Patterson, Figure No. 267 may be used. The hanger shall be attached to concrete structures using double expansion shields, or to steel support members using welding lugs similar to Carpenter and Patterson, Figure No. 220.

3. Pipe riser clamps shall be used to support all vertical pipes extending through floor slabs. Riser clamps shall be galvanized steel similar to Carpenter and Patterson, Figure No. 126. Copper clad or PVC coated clamps shall be used on copper pipes. Insulation shall be removed from insulated pipes prior to installing riser clamps.

4. Unless otherwise specified, shown, or specifically approved by the Engineer, vertical runs exceeding 12-ft shall be supported by approved pipe collars, clamps, brackets or wall rests at all points required to insure a rigid installation.

2.08 SPECIAL SUPPORTS

A. Pipe supports shall be provided for closely spaced vertical piping systems as shown on the Drawings or as otherwise required to provide a rigid installation. The support system shall consist of a framework suitably anchored to floors, ceilings and walls and be as manufactured by the Unistrut Corporation; Globe-Strut by the Metal Products Division of U.S. Gypsum or equal.

B. Vertical and horizontal supporting members shall be U shaped channels similar to Unistrut, Series P1000. Vertical piping shall be secured to the horizontal members by pipe clamps or pipe straps equal to Unistrut, Series P1100M and Series P2558. All components shall be of mild steel.

C. The assemblies shall be furnished complete with all nuts, bolts and fittings required for a complete assembly including end caps for all members.

D. The design of each individual framing system shall be the responsibility of the Contractor. Shop drawings, as specified above shall be submitted and shall show all details of the installation, including dimensions and types of supports. In all instances the completed frame shall be adequately braced to provide a complete rigid structure when all the piping has been attached.

E. Any required pipe supports for which the supports specified in this Section are not applicable shall be fabricated or constructed from standard structural steel shapes in accordance with applicable provisions of Section 05500, have anchor hardware similar to items previously specified herein, shall meet the minimum requirements listed below and be subject to the approval of the Engineer.

1. Pipe support systems shall meet all requirements of this Section and all related Sections.

2. Complete design details of the entire pipe support system shall be provided for review by the Engineer in the submittals specified in Paragraph 1.03 above.

3. The pipe support system shall not impose loads on the supporting structures in excess of the loads for which the supporting structure is designed.

2.09 SURFACE PREPARATION AND SHOP PRIME PAINTING

A. All surfaces shall be prepared and shop painted as part of the work of this Section. Surface preparation and shop painting shall be as specified in Section 09901.

PART 3 EXECUTION

3.01 INSTALLATION

A. All pipes, horizontal and vertical, requiring rigid support shall be supported from the building structure by approved methods. Supports shall be provided at changes in direction and elsewhere as shown in the Drawings or specified herein. No piping shall be supported from metal stairs, ladders and walkways unless specifically directed or authorized by the Engineer.

B. All pipe supports shall be designed with liberal strength and stiffness to support the respective pipes under the maximum combination of peak loading conditions to include pipe weight, liquid weight, liquid movement and pressure forces, thermal expansion and contraction, vibrations and all probable externally applied forces. Prior to installation, all pipe supports shall be approved by the Engineer.

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C. Pipe supports shall be provided to minimize lateral forces through valves, both sides of split type couplings and sleeve type couplings, and to minimize all pipe forces on pump housings. Pump housings shall not be utilized to support connecting pipes.

D. Inserts for pipe hangers and supports shall be installed on forms before concrete is placed. Before setting these items, all Drawings and figures shall be checked which have a direct bearing on the pipe location. Responsibility for the proper location of pipe supports is included under this Section.

E. Continuous metal inserts shall be embedded flush with the concrete surface.

3.02 TESTING

A. All pipe support systems shall be tested for compliance with this Section. After installation, each pipe support system shall be tested in conjunction with the respective piping pressure tests. If any part of the pipe support system proves to be defective or inadequate, it shall be repaired or augmented under this Section to the satisfaction of the Engineer.

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SECTION 15250

THERMAL INSULATION

PART 1 GENERAL

1.01 SCOPE OF WORK

A. This Section specifies the basic materials and methods of installation for insulation for piping systems.

1.02 RELATED WORK

A. Mechanical Piping Systems are specified in other Sections of Division 15.

1.03 SUBMITTALS

A. Submit, in accordance with Sections 01300 and 01730, the following for each insulation by System: manufacturer's product data showing conformance with this Section for all required insulation, jackets, covers, coatings, adhesives, fasteners, supports and appurtenances; complete manufacturer's instructions for installation of all required items.

B. All submittals shall contain a statement that Sections defining specific insulation types and thickness and all other referenced Sections have been read and complied with. The certification statement shall specify the specific Sections and be made by all of the following that are applicable; the Contractor, sub-contractor and the vendor. The statement shall be an individual statement for each party involved, and shall be included with every submittal and resubmittal.

C. All materials deliveries must have accompanying manufacturer's certifications attesting to satisfactory results of product testing showing conformance with this Section.

D. For units that will be shipped exposed, provide a description of the protective packaging that will be used during transit

E. In general, corrections or comments or lack there of, made relative to submittals during review shall not relieve the contractor from compliance with the requirements of the drawings and specifications. Submittals are for review of general conformance with the design concepts of the project and general compliance with the contract documents. The contractor is responsible for the final design conforming and correlating all quantities and dimensions, selecting fabrication processes and techniques of construction, coordinating the work of all trades, and performing the work in a safe and satisfactory manner.

1.04 REFERENCE STANDARDS

A. National Fire Protection Association (NFPA)

B. Occupational Safety and Health Administration (OSHA)

C. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.05 QUALITY ASSURANCE

A. The insulation materials to be furnished under this section shall be essentially the standard products of manufactures regularly engaged in the manufacture of insulation systems.

B. Several manufacturers are indicated as acceptable for each type of insulation in these specifications. The Insulation Sub-contractor shall be responsible for determining that all insulation supplied for the project is suitable for installation in the spaces indicated. The Insulation Sub-contractor shall also insure that all materials used are compatible and in compliance with applicable codes and standards.

C. The Owner and Engineer reserve the right to sample and test any materials after delivery and to reject all components represented by a sample that fails to comply with the specified requirements.

1.06 DELIVERY, STORAGE AND HANDLING

A. All materials shall be inspected for size, quality and quantity against approved shop drawings upon delivery.

B. Delivery schedule of all equipment shall be coordinated with the Contractor. Equipment ready for shipment prior to the agreed on shipping date shall be stored without cost to the Owner by the manufacturer.

C. All equipment shipped that is exposed such as on a flat bed truck shall be protected during transit. The equipment shall be protected from moisture, road salt, dirt and stones or other materials thrown up from other vehicles. Electrical components shall be protected as above, but with special attention to moisture. The method of shipment protection shall be defined in the submittals.

D. All materials shall be suitably packed for shipment and long term storage. Each package shall be labeled to indicate the project and the contents of each package. Where applicable, equipment numbers shall be marked on the container.

E. All materials shall be stored in a covered dry location off of the ground. When required to protect the materials they shall be stored in a temperature-controlled location.

1.07 DEFINITIONS

A. Particular terminology used under this Section is defined as follows:

1. Traffic Level and Personnel Level - Areas, including process areas, equipment rooms, boiler rooms and other areas where insulation may be damaged by normal activity and local personnel traffic. Area extends to 8-ft above floor, walkways, platforms and stairs, and horizontally 3-ft beyond the edge of walkways, platforms, and stairs.

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2. Exposed Piping - Piping and ductwork visible from the floor level and includes all piping and ductwork in equipment rooms, boiler rooms, etc.

3. Concealed Piping - Piping and ductwork not visible from the floor level and includes piping and ductwork above hung ceilings and in shaftways.

4. Ventilated Spaces - Areas supplied with outdoor air on a continuous or intermittent basis. The outdoor air may be heated and/or cooled or untreated.

5. Heated Spaces - Areas where heat is supplied to maintain a minimum temperature during the heating season.

6. Unheated Spaces - Areas where heat is not applied and there is no minimum temperature during the heating season.

7. Conditioned Spaces - Areas that are provided with heating and mechanical cooling.

8. Non-Conditioned Spaces - Areas that are not provided with mechanical cooling.

9. Indoor Piping - Piping within a building that is not exposed to the weather.

10. Outdoor Piping - Piping that is not within a building and which is exposed to the weather.

## PART 2 PRODUCTS

### 2.01 GENERAL

A. All materials and integrated insulation assemblies furnished shall have flame spread ratings of not over 25 (fire resistive), smoke developed rating of not over 50 and fuel contributed rating of not over 50, as established by tests conducted in accordance with Interior Federal Standard No. 00136B, entitled "Interior Federal Standard Flame-Spread Properties for Materials" and the National Fire Code of the NFPA. The treatment of jackets or facings to impart flame and smoke safety must be permanent. (The use of water-soluble treatment is prohibited.) Exception allowed for closed cell foam insulation and PVC fitting covers.

B. The toxicity of the solvents used shall not exceed a maximum allowable concentration of 200 ppm or the latest value published by the American Conference of Governmental Industrial Hygienists and OSHA.

C. Adhesives, coatings and vapor barrier materials shall be compatible with the insulation as recommended by the insulation manufacturer. Submit a certified statement attesting to the approval of the materials by the insulation manufacturer. Adhesives and coatings shall be manufactured by Foster Div.; H.B. Fuller Co.; Childers Products Co. or equal. H.P. Fuller and Childers Products Nos are listed below by adhesive/coating types.

1. Lagging adhesive: 30-36, CP50, AMV-1.

2. Vapor barrier coating: 30-35, CP30.

3. Vapor seal adhesive: 85-75, CP82.

4. Sealing compound adhesive: 30-45, CP70.

5. Weatherproof mastic: 35-01, CP10-1.

2.02 INSULATION FOR COLD PIPING WITH VAPOR BARRIER (TYPE I-3)

A. Cold piping systems with vapor barrier include but are not limited to:

1. Potable Water

2. Non-potable Process Water

3. Chemical piping, Outdoor and in vaults.

4. Instrumentation and sample piping carrying water outdoor and in vaults.

B. Insulation Material - Molded rigid fiberglass sectional pipe insulation rated to 500 degrees F. The insulation shall have a minimum density of 3.5 lbs/cu ft and a maximum "K" factor of 0.24 at 75 degrees F mean temperature.

C. Jacket

1. Indoor Piping - Jacket shall be kraft paper bonded to aluminum foil reinforced with fiberglass yarn and self sealing lap with a maximum permeability of 0.02 perms with field applied 0.016-in thick aluminum jacket.

2. Outdoor Piping - Jacket shall be kraft paper bonded to aluminum foil reinforced with fiberglass yarn and self sealing lap with a maximum permeability of 0.02 perms with field applied 0.016-in thick aluminum jacket.

D. Fittings Covers

1. Indoor Piping - Premolded one piece PVC covers

2. Outdoor Piping - Preformed aluminum covers

E. Acceptable manufacturers shall be Manville Corp.; Certain-Teed; Owens-Corning Fiberglas or equal.

2.03 INSULATION FOR HOT PIPING (TYPE I-1)

A. Hot piping systems include but are not limited to:

1. Aeration air

B. Insulation Material - Molded rigid fiberglass sectional pipe insulation rated to 500 degrees F. The insulation shall have a minimum density of 3.5 lbs/cu ft and a maximum "K" factor of 0.29 at 200 degrees F mean temperature.

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C. Jacket

1. Outdoor Piping - Jacket shall be factory or field applied 0.016-in thick aluminum.

D. Fittings Covers

1. Outdoor Piping - Preformed one piece PVC covers.

E. Acceptable manufacturers shall be Manville Corp.; Certain-Teed; Owens-Corning Fiberglas or equal.

PART 3 EXECUTION

3.01 GENERAL

A. Do not apply insulation prior to testing and acceptance of piping, ductwork and/or equipment. Insulation shall not be applied to damp or frosty surface. Clean dust, dirt, grease and moisture from surfaces of pipe and ducts before applying insulation or insulation adhesives. Nameplates and equipment certification and data tags affixed to any piece of apparatus shall not be covered. Where two layers of insulation are used, stagger all joints both ways. Secure each layer independently. Continue insulation and jacketing through walls, partitions, floors and pipe sleeves.

B. The Contractor shall not install any equipment or materials until the Owner and Engineer have approved all submittals. If any equipment or materials are installed prior to approval of the submittals, it shall be at the Contractor's risk.

C. Insulation, adhesives, coatings and vapor barrier materials shall be applied in accordance with manufacturer's recommendations. Do not apply these materials when ambient temperature is above or below the maximum and minimum ambient temperature respectively, specified as limits by the manufacturer.

D. All penetrations through a vapor barrier for hangers, instruments, etc, shall be sealed to provide a complete vapor barrier. The use of staples or other fasteners that penetrate the vapor barrier is not permitted.

E. Insulation systems that require a vapor barrier shall be installed with an intact vapor barrier that covers the entire pipe, duct, or piece of equipment to be insulated. All edges of insulation that do not abut another piece of insulation shall have the vapor barrier extended, and sealed to the item being insulated. All penetrations through the insulation such as for thermowells, test ports, dampers, nameplates, or other items shall have the vapor barrier extend over the edges of the insulation and sealed to the item being insulated. Where items are mounted on ductwork a standoff shall be provided to protect the vapor barrier. The vapor barrier shall be sealed to the standoff.

F. For insulated items exceeding 100 square feet, or 20 feet in length, extend the vapor barrier to the item being insulated to reduce the area or length within a single enclosed area to the dimensions listed above.

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3.02 INSTALLATION OF PIPING INSULATION

A. Pipe shields and pipe saddles shall be provided as specified in Section 15505.

B. Preformed sectional insulation and jacketing shall be used where possible. The use of blanket insulation will be limited to fittings that cannot be insulated with sectional insulation. All joints on preformed and fabricated insulation shall be accurately fitted to eliminate voids. Voids shall be eliminated by refitting or replacing the insulation. End joints shall be firmly butted to adjoining sections of insulation.

C. Outdoor piping insulation shall be installed so as to keep the insulation dry. Joints shall be located to prevent the entrance of water. Breaks in jacketing caused by vertical connections or instruments shall be protected by hoods or cones. Where there are breaks in the jacket, plastic moisture barriers shall be provided under the jacketing to protect the insulation. Insulation and jacketing of valves shall be waterproofed. Insulation and jacketing of the valve shall be removable to allow servicing of the valve.

D. Vapor seal adhesive shall be used to seal seams and to butt sections on all cold piping if self sealing laps are not provided. The use of staples or any other fastening method that would penetrate the vapor barrier will not be permitted on cold piping systems. Staples may be used on hot piping systems where there is no potential for condensation.

E. Metal or plastic jacketing shall have its joints staggered from those of the insulation. Joints between jacketing and insulation shall be a minimum of 3-in.

F. Metal or plastic jacketing shall have a minimum 3-in overlap on longitudinal joints and end joints. Longitudinal joints in horizontal piping shall have the outer lap of the joint pointed down to shed water. The end of the outer lap shall be located at the 5 or 7 o'clock positions.

G. Where piping is provided with electric or steam heat tracing the insulation shall not be installed until the heat tracing has been tested and accepted. Insulation shall be sized to allow for the heat tracing line without deforming the insulation.

H. Where supports, anchors or guides are in direct contact with cold piping, insulate the item in contact a distance of four times the insulation thickness. Clamps and non-welded support devices shall be contained within the insulation. The space within insulating saddles at pipe hangers shall be filled with insulation.

I. On vertical risers exceeding 15-ft in height, provide intermediate support for the insulation. For carbon steel pipe, this support shall consist of angle clips or other suitable devices welded to the pipe at about 15-ft on centers and concealed by the pipe covering. On non-carbon steel piping, clamps or other non-welded devices shall be used.

J. Unless otherwise specified insulate all valves, control valves, fittings, pipe specialties and all other components that could be construed as being part of the piping system. Insulate valve bonnets to a point just below the stuffing box.

K. Bridge flanges, unions, and pipeline strainers with block or sectional insulation wired in place. Wire shall be black steel, annealed. Stop the pipe insulation a sufficient distance to allow removal of flange bolts without disturbing the pipe insulation and extend the block, at least

2-in over the adjacent pipe insulation. Flange covers shall be designed for removal without damaging the pipe insulation. Fill voids with blanket insulation.

L. Where there are lines run between two different piping systems, e.g. make up water line between city water and chilled water, the interconnecting line shall be insulated the same as the system having the most rigid requirements. If one of the lines is not insulated the interconnecting line shall be insulated the same as the insulated line.

M. Where possible, all insulation shall be continuous through wall and floor openings and sleeves.

3.03 INSULATION FOR COLD PIPING WITH VAPOR BARRIER (TYPE I-3)

A. Installation

1. Apply insulation in thicknesses indicated. Laps and joints shall be sealed using self-sealing laps or vapor barrier tape. Laps in horizontal piping shall be at the top. Seal ends of insulation sections at flanges, valves and fittings on 15-ft centers in straight pipe with vapor barrier coating that extends from vapor barrier jacket to the piping. All penetration of the vapor barrier shall be sealed vapor tight, including staples if used.

2. Where field applied aluminum jacket is specified the jacket shall be attached with aluminum draw bands located within 3-in of each joint and 24-in on centers maximum. Jackets on outdoor piping shall have joints arranged to shed water.

3. Fittings shall be molded fiberglass or mitered sections of pipe insulation to provide the same insulation value as required for straight piping. PVC fitting covers, where specified, shall be sealed with vapor seal adhesive. Circumferential edges shall be wrapped with vapor barrier tape. Where preformed aluminum fitting covers are specified a vapor barrier coating reinforced with glass cloth shall be applied directly to the insulation before installing the fitting cover. The vapor barrier shall be installed in accordance with the coating manufacturer's instructions. Aluminum fitting covers shall be attached with aluminum draw bands with joints located to shed water.

B. Insulation thickness shall be as specified in the respective piping system section.

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# *DIVISION 16*

# *ELECTRICAL*

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SECTION 16000

ELECTRICAL - GENERAL PROVISIONS

PART 1 GENERAL

1.01 SCOPE OF WORK

A. Furnish all labor, materials and equipment required and install complete and make operational, electrical system as shown on the Drawings and as specified herein.

B. The work shall include the following:

1. Coordinate the electrical service requirements with the power company and provide the electrical service(s) from the Power Company at the locations indicated.

2. Provide conduit, wire and field connections for all motors, motor controllers, control devices, control panels and electrical equipment furnished under Divisions 1, 11, 13 and 15.

3. Provide conduit, wiring and terminations for variable frequency drives, reactors, harmonic filters, transformers and power factor correction capacitors furnished and mounted under other related Divisions.

C. Each bidder or their authorized representatives shall, before preparing their proposal, visit all areas of the existing buildings and structures in which work under this sub-bid is to be performed and inspect carefully the present installation. The submission of the proposal by this bidder shall be considered evidence that their representative has visited the buildings and structures and noted the locations and conditions under which the work will be performed and that he/she takes full responsibility for a complete knowledge of all factors governing his/her work.

1.02 SUBMITTALS

A. As a minimum all equipment specified in each Section of Division 16 shall be submitted at one time. As an example all lighting fixtures shall be submitted together, all motor control centers shall be submitted together, etc. Submittals that do not comply will be returned disapproved.

B. Mark submittals to clearly identify proposed equipment including accessories, options, and features and to exclude parts not applicable to the project. When manufacturer's cut sheets apply to a product series rather than a specific product, the data specifically applicable to the project shall be highlighted or clearly indicated by other means. Each submittal piece of literature and each submittal drawing shall clearly reference the Project Specification and/or Contract Drawing that the submittal is to cover. General catalogs will not be accepted as cut sheets to fulfill submittal requirements.

C. Check shop drawings for accuracy prior to submittal. Shop drawings shall be stamped with the date checked and a statement indicating that the shop drawings conform to this Section and the Drawings. This statement shall also list all exceptions to this Section and the Drawings. Mark submittals to identify proposed equipment including accessories, options and features being

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proposed for approval and exclude parts not to be used. Shop drawings not so checked and noted shall be returned marked NOT APPROVED.

D. The Engineer's check shall be for conformance with the design concept of the project and compliance with this Section and the Drawings. Errors and omissions on approved shop drawings shall not relieve the Contractor from the responsibility of providing materials and workmanship required by this Section and the Drawings.

E. All dimensions shall be field verified at the job site and coordinated with the work of all other trades.

F. Material shall not be ordered or shipped until the shop drawings have been approved. No material shall be ordered or shop work started if shop drawings are marked "APPROVED AS NOTED - CONFIRM," "APPROVED AS NOTED - RESUBMIT" or "NOT APPROVED."

G. Operation and Maintenance Data

1. Submit operations and maintenance data for equipment furnished under this Division, in accordance with Section 01730. The manuals shall be prepared specifically for this installation and shall include catalog data sheets, drawings, equipment lists, descriptions, parts lists including replacement part numbers, to instruct operating and maintenance personnel unfamiliar with such equipment.

2. Manuals shall include the following as a minimum:

a. A complete "As-Built" set of approved shop drawings.

b. A complete list of the equipment supplied, including serial numbers, ranges and pertinent data.

c. Detailed service, maintenance and operation instructions for each item supplied.

H. Exceptions for Submittals

1. Exceptions to the Specifications or Drawings shall be clearly defined by the Electrical Subcontractor in a separate section of each submittal package. The submittal shall contain the reason for the exception, the exact nature of the exception and the proposed substitution so that a proper evaluation may be made by the Engineer. The acceptability of any device or methodology submitted as an "or equal" or "exception" to the Specifications shall be at the sole discretion of the Engineer.

2. By noting the term "compliance", it shall be understood that the manufacturer is in full compliance with the item specified and will provide exactly the same with no deviations.

3. By noting the term "deviation", it shall be understood that the manufacturer prefers to provide a different component in lieu of the one specified and in so doing, takes full responsibility for making the equipment work as specified and will provide any and all ancillary components to make the equipment work at no extra cost to the Owner.

4. By noting the term "alternate", it shall be understood that the manufacturer proposes to provide the same operating function but prefers to do it in a different manner and in so

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doing, takes full responsibility for making the equipment work as specified and will provide any and all ancillary components to make the equipment work at no extra cost to the Owner. The alternate method shall be fully described with schematic diagrams and one-line diagrams as applicable.

1.03 REFERENCE STANDARDS

A. Electric equipment, materials and installation shall comply with the National Electrical Code (NEC).

B. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.04 PRIORITY OF THE CONTRACT DOCUMENTS

A. If, during the performance of the work, the Contractor finds a conflict, error or discrepancy between or among one or more of the Sections or between or among one or more Sections and the Drawings, furnish the higher performance requirements. The higher performance requirement shall be considered the equipment, material, device or installation method which represents the most stringent option, the highest quality or the largest quantity.

B. In all cases, figured dimensions shall govern over scaled dimensions, but work not dimensioned shall be as directed by the Engineer and work not particularly shown, identified, sized, or located shall be the same as similar work that is shown or specified.

C. Detailed Drawings shall govern over general drawings, larger scale Drawings take precedence over smaller scale Drawings, Change Order Drawings shall govern over Contract Drawings and Contract Drawings shall govern over Shop Drawings.

D. If the issue of priority is due to a conflict or discrepancy between the provisions of the Contract Documents and any referenced standard, or code of any technical society, organization or association, the provisions of the Contract Documents will take precedence if they are more stringent or presumptively cause a higher level of performance. If there is any conflict or discrepancy between standard specifications, or codes of any technical society, organization or association, or between Laws and Regulations, the higher performance requirement shall be binding on the Contractor, unless otherwise directed by the Engineer.

E. In accordance with the intent of the Contract Documents, the Contractor accepts the fact that compliance with the priority order specified shall not justify an increase in Contract Price or an extension in Contract Time nor limit in any way, the Contractor's responsibility to comply with all Laws and Regulations at all times

1.05 ENCLOSURE TYPES

A. Unless otherwise required, electrical enclosures shall be NEMA Types as follows:

1. NEMA 4 in outdoor locations, rooms below grade including basements and buried vaults and "WET" locations shown on the Drawings.

2. NEMA 4X in "CORROSIVE" locations shown on the Drawings.

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1.06 SERVICE AND METERING

A. Service will be obtained at 480 Volts, 3Phase, 4Wire, 60 Hz.

B. The Contractor shall be responsible for the following work:

1. Obtain an estimate from the power company for the work described above and include the cost of the power company work in the Bid Price.

2. Make all arrangements with the power company for obtaining electrical service, pay all power company charges.

1.07 CODES, INSPECTION AND FEES

A. Equipment, materials and installation shall comply with the requirements of the local authority having jurisdiction.

B. Obtain all necessary permits and pay all fees required for permits and inspections.

1.08 INTERPRETATION OF DRAWINGS

A. Unless specifically stated to the contrary, the Drawings do not show exact locations of conduit runs. Coordinate the conduit installation with other trades and the actual supplied equipment.

B. Install each 3 phase circuit in a separate conduit unless otherwise shown on the Drawings.

C. Conduit shown exposed shall be installed exposed; conduit shown concealed shall be installed concealed. Unless otherwise indicated install branch circuit conduits exposed in process/ industrial type spaces and concealed in finished spaces.

D. Where circuits are shown as "home-runs" all necessary fittings and boxes shall be provided for a complete raceway installation. Where home-runs indicate conduit is to be installed concealed or exposed the entire branch circuit shall be installed in the same manner.

E. Verify the exact locations and mounting heights of lighting fixtures, switches and receptacles prior to installation.

F. Except where dimensions are shown, the locations of equipment, fixtures, outlets and similar devices shown on the Drawings are approximate only. Exact locations shall be determined by the Contractor and approved by the Engineer during construction. Obtain information relevant to the placing of electrical work and in case of any interference with other work, proceed as directed by the Engineer and furnish all labor and materials necessary to complete the work in an approved manner.

G. Circuit layouts are not intended to show the number of fittings, or other installation details. Furnish all labor and materials to install and place in satisfactory operation all power, lighting and other electrical systems shown.

H. Redesign of electrical or mechanical work, which is required due to the Contractor's use of an alternate item, arrangement of equipment and/or layout other than specified herein, shall be done by the Contractor at his/her own expense. Redesign and detailed plans shall be submitted to the

Engineer for approval. No additional compensation will be provided for changes in the work, either his/her own or others, caused by such redesign.

I. Raceways and conductors for low voltage (120 Volts) thermostats controlling HVAC unit heaters, exhaust fans and similar equipment are not shown on the Drawings. Provide raceways and conductors between the thermostats, the HVAC equipment and the motor starters for a complete and operating system. Raceways shall be installed concealed in all finished space and may be installed concealed or exposed in process spaces. Refer to the HVAC drawings for the locations of the thermostats.

1.09 SIZE OF EQUIPMENT

A. Investigate each space in the structure through which electrical equipment furnished under Division 16 must pass to reach its final location. Coordinate shipping splits with the manufacturer to permit safe handling and passage through restricted areas in the structure.

B. The equipment shall be kept upright at all times during storage and handling. When equipment must be tilted for passage through restricted areas, brace the equipment to ensure that the tilting does not impair the functional integrity of the equipment.

1.10 RECORD DRAWINGS

A. As the work progresses, legibly record all field changes on a set of Project Contract Drawings, hereinafter called the "Record Drawings."

1.11 MATERIALS AND EQUIPMENT

A. Materials and equipment furnished under this contract shall be new.

B. Material and equipment of the same type shall be the product of one manufacturer and shall be UL listed.

1.12 EQUIPMENT IDENTIFICATION

A. Identify equipment, disconnect switches, separately mounted motor starters, control stations, etc. furnished under Division 16 with the name of the equipment it serves. Motor control centers, control panels, panelboards, switchboards, switchgear, junction or terminal boxes, transfer switches, etc, shall have nameplate designations as shown on the Drawings.

B. Nameplates shall be engraved, laminated plastic, not less than 1/16-in thick by 3/4-in by 2-1/2-in with 3/16-in high white letters on a black background.

C. Nameplates shall be screw mounted to NEMA 1 enclosures. Nameplates shall be bonded to all other enclosure types using an epoxy or similar permanent waterproof adhesive. Two sided foam adhesive tape is not acceptable. Where the equipment size does not have space for mounting a nameplate the nameplate shall be permanently fastened to the adjacent mounting surface.

PART 2 PRODUCTS (NOT USED)

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PART 3 EXECUTION

3.01 LEEVES AND FORMS FOR OPENINGS

A. Provide and place all sleeves for conduits penetrating floors, walls, partitions, etc. Locate all slots for electrical work and form before concrete is poured.

B. Exact locations are required for stubbing-up and terminating concealed conduit. Obtain shop drawings and templates from equipment vendors or other subcontractors and locate the concealed conduit before the floor slab is poured.

C. Where setting drawings are not available in time to avoid delay in scheduled floor slab pours, the Engineer may allow the installations of such conduit to be exposed. Requests for this deviation must be submitted in writing. No additional compensation for such change will be allowed.

3.02 CUTTING AND PATCHING

A. Cutting and patching shall be done in a thoroughly workmanlike manner and be in compliance with modifications and repair to concrete as specified. Saw cut concrete and masonry prior to breaking out sections.

3.03 INSTALLATION

A. Work not installed according to the Drawings and Specification shall be subject to change as directed by the Engineer at Contractor's expense.

B. Electrical equipment shall be protected against mechanical and water damage. Store all electrical equipment in dry permanent shelters. Do not install electrical equipment in place until structures are weather-tight.

C. Damaged equipment shall be replaced or repaired by the equipment manufacturer, at the Engineer's discretion and at the Contractor's expense.

D. Repaint any damage to factory applied paint finish using touch-up paint furnished by the equipment manufacturer.

3.04 WORK SUPERVISION

A. The Contractor shall designate in writing the qualified electrical supervisor who shall provide supervision to all electrical work on this project. The minimum qualifications for the electrical supervisor shall be a master electrician as defined by the Arkansas Board of Electrical Examiners. The supervisor or his appointed alternate possessing at least a journeyman electrician license shall be on site whenever electrical work is being performed. The qualifications of the electrical supervisor shall be subject to approval of the Owner and the Engineer.

B. All master and journeyman electricians shall be licensed in accordance with Arkansas Code Title 17 Chapter 28 - Electricians. The website located at http://www.arkleg.state.ar.us publishes the text of this statutory requirement. No unlicensed electrical workers shall perform work on this project. Apprentice electricians in a ratio of not more than one apprentice per journeyman electrician will be allowed if the apprentices are licensed and actively participating in an apprenticeship program recognized and approved by the Arkansas Board of Electrical Examiners.

END OF SECTION

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SECTION 16110

RACEWAYS, BOXES, FITTINGS AND SUPPORTS

PART 1 GENERAL

1.01 SCOPE OF WORK

A. Furnish and install complete raceway systems as shown on the Drawings and as specified herein.

B. Home runs indicated are to assist the contractor in identifying raceways to be installed concealed or exposed. Raceways identified to be installed exposed on the Drawings shall be run near the ceilings or along the walls of the areas through which they pass and shall be routed to avoid conflicts with HVAC ducts, cranes and hoists, lighting fixtures, doors and hatches. Raceways indicated to be run concealed shall be run in the center of concrete floor slabs, in partitions, or above hung ceilings, as required.

PART 2 PRODUCTS

2.01 RACEWAYS AND FITTINGS

A. Steel Conduit and Fittings

1. Rigid metal conduit (GRS), couplings, factory elbows and fittings shall be heavy wall steel tubing with a hot-dipped galvanized finish inside and out after threading and shall comply with ANSI C 80.1 and UL/6.

2. Intermediate metal conduit (IMC), couplings, factory elbows and fittings shall be medium wall steel tubing with a hot-dipped galvanized finish inside and out after threading and shall comply with UL/1242.

3. Electrical metallic tubing (EMT), factory elbows and fittings shall be thin wall steel tubing with an electrically galvanized finish after fabrication and comply with ANSI C80.3 and UL/797.

4. Acceptable manufacturers:

a. Allied Tube & Conduit Corp.

b. LTV Steel Tubular Products Corp.

c. Triangular PWC Inc.

d. Or equal.

5. Rigid metal and intermediate metal conduit fittings shall be of the threaded type, and shall be steel or malleable iron, with a hot-dipped galvanized finish. Threadless fittings and split couplings are not allowed except in specific applications as approved by the Engineer.

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6. Electrical metallic tubing fittings shall be of the rain tight, concrete tight, compression type with malleable iron or pressure cast steel body, steel hex type compression nut and electrically galvanized finish.

7. Acceptable manufacturers:

   a. Appleton Electric Co.

   b. O-Z Gedney Co.

   c. RACO Inc.

   d. Gould/Efcor

   e. Steel City

   f. Or equal

B. PVC Coated Rigid Steel Conduit and Fittings

1. PVC coated rigid steel conduit shall be heavy wall steel tubing with a hot-dipped galvanized finish inside and out after threading with a minimum 0.040-in thick, polyvinyl chloride coating permanently bonded to it and an internal chemically cured urethane or enamel coating. The rigid steel conduit shall comply with ANSI C80.1 and UL/6 prior to coating.

2. PVC coated couplings, factory elbows and fitting shall be furnished with a PVC coating bonded to steel the same thickness as used on the PVC coated conduit. The ends of all couplings, fittings, etc. shall have a minimum of one pipe diameter in length of PVC overlap.

3. Acceptable manufacturers:

   a. "OCAL" as manufactured by Thomas & Betts

   b. "Plasti-Bond Red" as manufactured by Robroy Industries

   c. Triangle PWC Inc

   d. Or equal

C. Non Metallic Conduit and Fittings

1. PVC conduit shall be rigid polyvinyl chloride schedule 40. Rigid PVC conduit up to trade sizes 3-1/2-in shall comply with NEMA TC-2 and UL/651 and shall be sunlight resistant, rated for use with 90 degree C conductors in exposed, direct burial or concrete encased applications. Underground utility duct, 4-in trade size and above, shall be polyvinyl chloride (PVC).

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2. Connectors, couplings, fittings and ancillary materials shall be supplied by the conduit manufacturer. Connectors, fittings and ancillary materials shall be rated for the environment for which they are installed.

3. Acceptable manufacturers:

   a. Carlon Corp.

   b. Certained Corp.

   c. Conux Pipe Systems, Inc.

   d. Or equal.

D. Liquid-tight Flexible Metal Conduit, Couplings and Fittings

1. Liquid-tight flexible metal conduit shall be square locked, galvanized steel flexible conduit with a moisture proof, flame resistant, polyvinyl chloride jacket, for use with rigid metal conduit systems. Sealtite, Type UA, manufactured by the Anaconda Metal Hose Div.; Anaconda American Brass Co.; American Flexible Conduit Co., Inc.; Universal Metal Hose Co. or equal.

2. Liquid-tight conduit fittings shall be hot-dipped mechanically galvanized, positive grounding, screw in type. Provide external bonding lugs on sizes 1-1/4-in and larger. Box connectors shall have insulated throats as manufactured by the Thomas & Betts Co.; Crouse-Hinds Co. or equal.

3. Acceptable Manufacturers:

   a. American Flexible Conduit Co.

   b. Anaconda Metal Hose/ANAMET Inc.

   c. Electri-flex Co.

   d. Thomas & Betts

   e. O-Z Gedney

   f. Or equal

## 2.02 BOXES AND FITTINGS

A. Dry and Damp Location Boxes and Fittings

1. Outlet boxes shall be zinc-galvanized, extra depth, pressed steel with knockouts and of size and type suitable for the intended application.

2. Boxes that are less than 100 cubic inches in size used for junction or pull boxes shall be zinc galvanized pressed steel not less than 14 USS gauge with appropriate blank covers, minimum size 4-11/16-in square by 2-1/8-in deep.

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3. Boxes that are 100 cubic inches and larger shall be constructed of hop dip galvanized sheet steel without knockouts. Covers shall be secured with round head brass machine screws. All joints shall be welded and ground smooth.

4. Terminal cabinets shall be NEMA 12 sheet steel unless otherwise shown on the Drawings. Boxes shall be painted and have continuously welded seams. Welds shall be ground smooth and galvanized. Box bodies shall be flanged and shall not have holes or knockouts. Box bodies shall not be less than 14 gauge metal and covers shall not be less than 12 gauge metal. Terminal boxes shall be furnished with latching hinged doors, terminal mounting straps and brackets. Terminal blocks shall be rated not less than 20A, 600V.

5. Acceptable Manufacturers:

   a. Appleton

   b. Raco

   c. Steel City

   d. Hoffman

   e. Electromate Division of Robroy Ind.

   f. Wiegmann

B. Wet Location Boxes and Fittings

1. NEMA 4 terminal boxes, junction boxes, pull boxes, etc, shall be sheet Type 316 stainless steel unless otherwise shown on the Drawings. Boxes shall have continuously welded seams and mounting feet. Welds shall be ground smooth. Boxes shall be flanged and shall not have holes or knockouts. Box bodies shall not be less than 14 gauge metal and covers shall not be less than 12 gauge metal. Covers shall be gasketed and fastened with stainless steel clamps. Terminal boxes shall be furnished with hinged doors, terminal mounting straps and brackets. Terminal blocks shall be NEMA type, not less than 20 Amps, 600 Volt.

2. Cast or malleable iron device boxes shall be Type FD. Boxes and fittings shall have cadmium-zinc finish with cast covers and stainless steel screws.

3. Cast aluminum device boxes shall be Type FD. Boxes and fittings shall be copper free aluminum with cast aluminum covers and stainless steel screws

4. Acceptable Manufacturers:

   a. Appleton

   b. Crouse-Hinds

   c. Steel City

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d. Hoffman

e. Electromate - Division of Robroy Ind.

f. Or equal

2.03 HARDWARE

A. Conduit Mounting Equipment

1. In dry indoor areas, hangers, rods, backplates, beam clamps, channel, etc shall be galvanized iron or steel.

2. Stainless steel channel with stainless steel hardware shall be used in areas designated "WET" or "CORROSIVE" on the Drawings and in outdoor locations.

3. Furnish any and all necessary supports, brackets, conduit sleeves, racks and bracing as required. All boxes and hardware shall be galvanized zinc plated steel except that stainless steel shall be used in areas designated as "WET" or "CORROSIVE" on the Drawings.

B. Conduit Supports

1. Trapezes

a. In dry indoor areas, beams, channels, struts, hangers, bracing, rods, beam clamps, accessories and components shall be galvanized steel.

b. Stainless steel beams, channels, struts or fiberglass beams, channels, struts with stainless steel hangers, bracing, rods, beam clamps, accessories and components shall be used in areas designated "WET", "DAMP" and "CORROSIVE" where indicated and in outdoor locations.

2. Conduit Racks

a. In dry indoor areas, conduit racks, accessories and components shall be galvanized steel.

b. Stainless steel conduit racks with stainless, accessories and components shall be shall be used in areas designated "WET", "DAMP" and "CORROSIVE" where indicated and in outdoor locations.

PART 3 EXECUTION

3.01 RACEWAY APPLICATIONS

A. Refer to Table 16110-1 for specific raceway application requirements.

B. All conduit of a given type shall be the product of one manufacturer.

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3.02 BOX APPLICATIONS

A. Terminal boxes, junction boxes and pull boxes shall have NEMA ratings suitable for the location in which they are installed.

B. All conduit bodies and pulling outlets shall comply with NEC wire bending space requirements. Mogul type fittings shall be used for sizes 2-1/2-in and larger.

***TABLE 16110-1***
***Raceway Application Guidelines***

| *Location/Circuit Type* | *Raceway Type* |
|---|---|
| All locations - raceways containing circuits above 600 Volts. | ▪ Exposed - Galvanized rigid steel (GRS) conduit.<br>▪ Concealed - Do not embed within structure. If this is not possible, use Schedule 40 PVC conduit.<br>▪ Underground - PVC duct (as specified) in concrete reinforced duct bank (as shown or noted).<br>▪ Avoid running through corrosive locations. |
| All locations<br><br>▪ Class 2 and 3 signal wiring and 4-20 mA instrumentation cables, non-fiber (copper) data highway. | ▪ Exposed - Galvanized rigid steel (GRS) conduit. Use PVC coated rigid steel conduit in corrosive areas.<br>▪ Concealed - Galvanized rigid steel (GRS) conduit.<br>▪ Underground - PVC duct (as specified) in concrete reinforced duct bank (as shown or noted).<br>▪ Use PVC coated steel conduit for single conduit direct burial applications. |
| Clean, dry finished areas - offices, administrative areas, lobbies, control room, lunch room, toilets, and laboratories, etc. | ▪ Conceal raceways in walls above hung ceilings in rooms and areas that have finished interiors. Surface raceway for multiple receptacle, voice, and data outlets in labs and control rooms or in offices where specified.<br>▪ 3/4 or 1-in electrical metallic tubing (EMT) for lighting, switch, and receptacle circuits exposed above hung ceilings or concealed in partition walls. Galvanized rigid steel (GRS) above 1-in.<br>▪ Flexible, armor interlocked cable assembly (Type MC) or flexible conduit may be used as branch circuit wiring in these areas. |
| Clean, dry non-finished areas - electrical rooms, generator rooms, mechanical rooms, shops, dry storage, etc. | ▪ Exposed conduit for power wiring, lighting, switch, and receptacle circuits - Galvanized rigid steel (GRS).<br>▪ Concealed conduit for power wiring, lighting, switch, and receptacle circuits - Schedule 40 PVC conduit when embedded within concrete floor slabs. GRS when embedded within masonry block walls. |

| *TABLE 16110-1*<br>*Raceway Application Guidelines* | |
|---|---|
| ***Location/Circuit Type*** | ***Raceway Type*** |
| Process areas - non-corrosive, non-hazardous locations designated as DAMP or WET on the Drawings. | ▪ Exposed conduit for power wiring, lighting, switch, and receptacle circuits - Galvanized rigid steel (GRS).<br>▪ Concealed conduit for power wiring, lighting, switch, and receptacle circuits - Schedule 40 PVC conduit when embedded within concrete floor slabs. GRS when embedded within masonry block walls. |
| Corrosive areas - chemical storage and handling areas, underground vaults, within tanks or clearwells, filter pipe galleries and locations where designated corrosive on the Drawings. | ▪ Exposed conduit for power wiring, lighting, switch, and receptacle circuits – PVC coated steel.<br>▪ Concealed conduit for power wiring, lighting, switch, and receptacle circuits - Schedule 40 PVC conduit when embedded within concrete floor slabs or structures. |
| Outdoor areas - all locations. | ▪ Exposed conduit for power wiring, lighting, switch, and receptacle circuits - Galvanized rigid steel (GRS). PVC conduit shall not be used exposed.<br>▪ Concealed conduit for power wiring, lighting, switch, and receptacle circuits - Schedule 40 PVC conduit when embedded within concrete structures. |

3.03 FITTINGS APPLICATIONS

A. Combination expansion-deflection fittings shall be used where exposed conduits cross structure expansion joints or in straight runs where expansion is anticipated. Combination expansion-deflection fittings shall be installed where embedded conduits cross structural expansion joints. Refer to Structural Drawings for expansion joint locations. Provide bonding jumpers around fittings.

B. All underground conduit penetrations at walls or other structures shall be sealed watertight. Conduit wall seals and sleeves shall be used in accordance with the manufacturer's installation instructions and the details shown on the Drawings.

C. Conduit sealing bushings shall be used to seal conduit ends exposed to the weather and at other locations shown on the Drawings.

D. Gas Containment Area Sealing

1. Internally and externally seal each conduit entering or leaving any area containing noxious gases to prevent contamination into clean areas via the conduit system. Areas requiring this protection are rooms where chlorine, ammonia and ozone are stored, generated or handled. Caulking material for conduit internal use shall be synthetic elastomer type, 3M,

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Series CP25 or equal. External sealing shall be in accordance with the typical details shown on the Drawings.

E. Insulated throat grounding bushings shall be used where specified herein and where conduits stub up into electrical equipment such as MCC's, switchgear, etc.

3.04 INSTALLATION

A. No conduit smaller than 3/4-in electrical trade size shall be used, nor shall any have more than the equivalent of three 90 degree bends in any one run. Pull boxes shall be provided as required by the NEC after every 270 degrees of bends and for straight run not to exceed 200 feet or as directed.

B. All conduit which may under any circumstance contain liquids such as water, condensation, liquid chemicals, etc, shall be arranged to drain away from the equipment served. If conduit drainage is not possible, conduit seals shall be used to plug the conduits. The ends of all conduits shall be temporarily plugged to exclude dust, moisture and debris from entering during construction.

C. Conduit ends exposed to the weather shall be sealed with conduit sealing bushings.

D. Conduits noted as spare shall be capped or plugged at both ends with easily removable fittings.

E. Conduit terminating in NEMA 3R, 4, 4X enclosures shall be terminated with Myers type conduit hubs.

F. Conduit terminating in pressed steel boxes shall have double locknuts and insulated bushings.

G. Conduits containing equipment grounding conductors and terminating in sheet steel boxes shall have insulated throat grounding bushings.

H. Conduits shall be installed using threaded fittings except for PVC or EMT.

I. The use of running threads is prohibited. Where such threads are necessary, a 3-piece union shall be used.

J. All conduits entering or leaving a motor control center, switchboard or other multiple compartment enclosure shall be stubbed up into the bottom horizontal wireway or other manufacturer's designated area, directly below the vertical section in which the conductors are to be terminated. The 3-in extension of conduit above the floor slab or concrete equipment pad may be reduced to a dimension that suits the equipment manufacturer's installation requirements if the 3-in stub-up interferes with the equipment being provided.

K. Rigid galvanized steel conduits buried in earth shall be completely painted with bitumastic.

L. Rigid galvanized steel conduits which have been field cut and threaded shall be painted with cold galvanizing compounds.

M. PVC coated rigid galvanized steel conduit shall be used for elbows at risers at the utility pole for electrical and telephone service conduits. Rigid galvanized steel conduit shall be used at utility pole for electrical and telephone service and fire alarm conduits to a height of 10-ft above

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finished grade. Furnish and install weather heads at service pole riser if required by utility company.

N. Liquid-tight flexible metal conduit shall be used for all motor terminations, the primary and secondary of transformers, generator terminations and other equipment where vibration is present or may require removal. Non-metallic flexible conduit can be used with rigid PVC conduit systems.

O. Flexible couplings shall be used in hazardous locations for all motor terminations and other equipment where vibration is present.

P. PVC coated rigid steel conduit shall be used as a transition section where concrete embedded conduit stubs out of floor slabs or through below grade walls or where conduit installed under building slabs on grade stub out of floors. The PVC coated rigid steel conduit shall extend a minimum of 3-in into and out of the floor slab, concrete pad, or wall to allow for proper threading of the conduit.

Q. Expansion fittings shall be used on exposed runs of PVC conduit where required for thermal expansion. Installation and number of fittings shall be as recommended by manufacturer.

R. Conduit supports, other than for underground raceways, shall be spaced at intervals not exceeding the distance required by the NEC to obtain rigid construction.

S. Single conduits shall be supported by means of one-hole pipe clamps in combination with one-screw back plates, to raise conduits from the surface. Multiple runs of conduits shall be supported on fabricated channel trapeze type racks with steel horizontal members and threaded hanger rods. The rods shall be not less than 3/8-in diameter. Surface mounted panel boxes, junction boxes, conduit, etc, shall be supported by spacers to provide a minimum of 1/2-in clearance between wall and equipment.

T. Conduit Supports (Other than Underground Raceways)

1. Trapezes

   a. Conduit support trapezes shall be vertically supported every 10-ft or less, as required to obtain rigid conduit construction.

   b. Lateral seismic restraints (Sway Bracing) shall be spaced 30-ft or less.

   c. Horizontal seismic restraints shall be spaced at 40-ft or less. There shall be at least one horizontal restraint per horizontal run.

   d. Attachment to structural steel shall be by beam clamps or welded beam attachment. C-clamps will not be allowed for vertical hangers. Side beam clamps with beam hooks shall be used for seismic restraint only.

   e. Attachment to concrete shall be cast-in-place inserts, cast-in place welded plates with welded studs or stainless steel adhesive anchors.

2. Flush Mounted Supports

a. Support shall be spaced 10-ft or less, as required to obtain rigid conduit construction.

b. Attachment to concrete shall be with cast-in-place inserts, cast-in place welded plates with welded studs or stainless adhesive anchors.

3. Conduit Racks

a. Support shall be spaced 10-ft or less, as required to obtain rigid conduit construction.

b. Horizontal seismic restraints shall be spaced at 30-ft or less, with welded studs or stainless adhesive anchors.

4. Conduit Hangers

a. Conduit hangers shall be vertical supported 10-ft or less, as required to obtain rigid conduit construction.

b. Lateral seismic restraints (Sway Bracing) shall be spaced 20-ft or less.

c. Horizontal seismic restraints shall be spaced at 30-ft or less. There shall be at least one horizontal restraint per horizontal run.

d. Attachment to structural steel shall be by beam clamps or welded beam attachment. C-clamps will not be allowed for vertical hangers. Side beam clamps with beam hooks shall be used for seismic restraint only.

e. Attachment to concrete shall be cast-in-place inserts, cast-in place welded plates with welded studs or stainless steel adhesive anchors.

5. All reinforcing bars shall be located by the Electrical Subcontractor with the use of a rebar locator prior to installing adhesive capsule type anchors. Mark the location of all reinforcing bars in an area bounded by a line drawn at least 18-in from the edge of the support bearing/weld plates on all four sides of the bearing/weld plates prior to fabricating and installing bearing/weld plates.

6. Where interference occurs, adjust anchor locations to clear reinforcing bars and alter support configuration at no additional cost to the Authority.

U. Miscellaneous steel for the support of fixtures, boxes, transformers, starters, contactors, panels and conduit shall be furnished and installed. Channel supports shall be ground smooth and fitted with plastic end caps.

V. Steel channels, flat iron and channel iron shall be furnished and installed for the support of all electrical equipment and devices, where required, including all anchors, inserts, bolts, nuts, washers, etc, for a rigid installation. Channel supports shall be ground smooth and fitted with plastic end caps.

W. 3/16-in polypropylene pull lines shall be installed in all new conduits noted as spares or designated for future equipment. Conduit noted as spare shall be capped or plugged at both ends with easily removable fittings.

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X. Where no type or size is indicated for junction boxes, pull boxes or terminal cabinets, they shall be sized in accordance with the requirements of NEC Article 314. Enclosure type and material shall be as specified herein.

Y. Pull or junction boxes shall be furnished and installed where shown on the Drawings, in every 200 feet of straight conduit runs or in runs where more than the equivalent of four 90 degree bends occur or at any point necessary for wire pulling and splicing. Splices shall not be made in pulling elbows.

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SECTION 16120

WIRES AND CABLES (600 VOLT MAXIMUM)

PART 1 GENERAL

1.01. SCOPE OF WORK

A. Furnish, install and test all wire, cable and appurtenances as shown on the Drawings and as specified herein.

1.02. DELIVERY, STORAGE AND HANDLING

A. Carefully handle all conductors to avoid kinks and damage to insulation.

PART 2 PRODUCTS

2.01. GENERAL

A. Wires and cables shall be of annealed, 98 percent conductivity, soft drawn copper.

B. All conductors shall be stranded, except that lighting and receptacle wiring may be solid.

C. Except for control, signal and instrumentation circuits, wire smaller than No. 12 AWG shall not be used.

D. Wire shall have 600 Volt insulation except where indicated otherwise.

2.02. BUILDING WIRE

A. Wire for lighting, receptacles and other circuits not exceeding 150 Volts to ground shall be NEC type THHN/THWNas manufactured by General Cable.; American Insulated Wire Corp.; Southwire Co.;or equal.

B. Wire for circuits over 150 Volts to ground within buildings and structures shall be NEC type THHN/THWN as manufactured by General Cable.; American Insulated Wire Corp.; Southwire Co.; or equal.

C. Wire for circuits over 150 Volts to ground used underground or for service entrance shall be NEC type RHH-RHW-2/USE-2, flame retardant and CT rated as manufactured by The Okonite Co.; General Cable.; American Insulated Wire Corp.; or equal.

D. Bare copper ground wire shall be stranded, annealed copper wire ASTM-B3 alloy coated soft copper electrical wire ASTM B189.

E. Equipment grounding conductors shall be NEC Type THW green and sized in accordance with NEC Table 250-122. Ground grid conductors shall be insulated unless shown otherwise on the Drawings.

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2.03. CONTROL, STATUS AND ALARM WIRE

A. Wire shall be No.14 AWG NEC type THHN/THWN stranded as manufactured by The Okonite Co.; General Cable.; American Insulated Wire Corp.; Southwire Co.; or equal.

2.04. INSTRUMENTATION WIRE

A. Wire for process instrumentation signals (i.e. 1-5 VDC, 4-20 mADC), R.T.D., potentiometer and similar signals shall be:

1. Single pair cable:

a. Conductors: 2 No. 16 stranded and twisted on 2-in lay

b. Insulation: XLP with 600 Volt, 105 degrees C rating

c. Shield: 100% Aluminum/polyester foil with drain wire

d. Jacket: PVC with UL Subject 13, UL 1581 and manufacturers' identification

e. Max overall diameter: 0.262-in

f. Miscellaneous: UL Listed as Instrument Tray Cable for use in accordance with Article 727 and Article 725 of the NEC.

g. Manufacturers: Belden; Manhattan; General Cable; The Okanite Co.;or equal

2. Area Network (LAN) Ethernet cable shall be designed for use with a high-speed (100 Mbps/Gbps) Ethernet communications network. The twisted pair cable shall have nominal impedance of 100 ohms at 1 Mhz and a maximum attenuation of 10 dB per 1000 feet at 1 Mhz. The twisted pair cable shall be plenum rated and shall have a minimum of four 24 AWG solid copper conductor pairs. All RJ-45 terminations on the twisted pair cable shall be done as specified by the manufacturer. Terminations shall provide strain relief on the cable jacket. Strain relief on the wire and /or wire insulation shall not be acceptable. Cable and connections shall meet or exceed Category 5 ratings and upon completion of the network installation, the system shall be tested to Category 5 standards. Category 5 cable shall be as manufactured by Belden; Phoenix; Digital; Seicor, or equal.

2.05. SPLICES (POWER CONDUCTORS)

A. Unless otherwise indicated on the Drawings, splices shall not be made in the cables without prior written approval of the Engineer. Where splicing is approved by the Engineer, splicing materials for all 600 Volt splices shall be made with long barrel, tin plated copper compression (hydraulically pressed) connectors and insulated with heavy wall heat shrinkable tubing. The conductivity of all completed connections shall be not less than that of the uncut conductor. The insulation resistance of all completed connections of insulated conductors shall be not less than that of the uncut conductor.

B. Wire lugs shall be tin plated copper, long barrel compression type (hydraulically pressed) for wire sizes No. 8 AWG and larger. Lugs for No. 10 AWG and smaller wire shall be locking spade type with insulated sleeve. Lugs shall be as manufactured by the Thomas and Betts Co.; Burndy;

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Amp; or equal.

C. Compression type connectors shall be insulated with a heat shrink boot or outer covering and epoxy filling. Splice kits shall be as manufactured by Raychem (Tyco); Ideal Industries; 3M Co. or equal.

D. Solderless pressure connectors shall be self-contained, waterproof and corrosion-proof units incorporating prefilled silicone grease to block out moisture and air. Connectors shall be sized according to manufacturer's recommendations. The connectors shall be UL listed and CSA approved, as manufactured by King Innovation; Ideal Industries, Inc., or equal.

2.06. MOTOR CONNECTIONS

A. Motor connections shall be ring type mechanical compression terminations installed on the branch circuit wires and the motor leads and secured with bolt, nut and springwasher. Connections shall be insulated with a Raychem Type RVC, roll-on stub insulator; Thomas & Betts, Shrink-Kon MSCV20; or equal. For wire sizes N0. 8 and larger, long barrel, tin plated copper compression (hydraulically pressed) type connections Burndy Co., or equal) shall be installed on the branch circuit wires and the motor leads. Connections shall be insulated with heavy duty heat shrinkable material (Raychem Corp., or equal.

2.07. TERMINATION AND SPLICES (CONTROL, STATUS AND ALARM CONDUCTORS)

A. Termination connectors shall be of the locking fork-end (upturned leg ends) type as manufactured by Ideal Industries; 3M Co.; Panduit Corp. or equal.

B. Insulated compression type connectors shall be of the expanded vinyl insulated parallel or pigtail type as manufactured by Ideal Industries; 3M Co.; Panduit Corp. or equal.

C. Solderless pressure connectors shall be self-contained, waterproof and corrosion-proof units incorporating prefilled silicone grease to block out moisture and air. Connectors shall be sized according to manufacturer's recommendations. The connectors shall be UL listed and CSA approved, as manufactured by King Innovation; Ideal Industries, Inc or equal.

2.08. TERMINATIONS (INSTRUMENTATION CABLES)

A. Termination connectors shall be of the locking fork-end (upturned leg ends) type as manufactured by Ideal Industries; 3M Co.; Panduit Corp. or equal.

2.09. WIRE AND CABLE MARKERS

A. Wire and cable markers shall be "Omni-Grip" as manufactured by the W.H. Brady Co.; Thomas & Betts Co., SMS; 3M Co., STD-TAG; or equal.

B. Wire and cables with diameters exceeding the capacity of the "Omni-Grip" shall be marked with pre-printed, self-adhesive vinyl tapes as manufactured by the W.H. Brady Co.; Panduit Corp.; 3M Co.; or equal.

2.10. PATCH PANELS (Fiber Optic)

A. Patch panels shall be suitable for wall mounting, comprised of internal mounting plate, slack

cable take up/organizer blocks, patch block with connectors and grounding lugs as indicated or required. Panels shall be NEMA 12 construction unless otherwise indicated on the Drawings. Patch panels shall be suitable for multimode system operation at 800 and 1300 nanometers.

B. Patch panels shall be as manufactured by Siecor Corp., Hickory, NC; 3M Telecom Systems Group, Austin, TX; AT&T Network Systems, Norcross, GA; or equal.

2.11. SPLICE CLOSURES (Fiber Optic)

A. Splice closures shall be constructed of thermoplastic, suitable for "butt" or "through" cable entry, moisture tight sealing arrangement, removable splice tray organizer, splice trays for mechanical splices, suitable for multimode system operation at 800 and 1300 nanometers, grounding lugs or equivalent for grounding cable armor.

B. Splice closures shall be as manufactured by Siecor Corp., Hickory, NC; 3M Telecom Systems Group, Austin, TX; AT&T Network Systems, Norcross, GA; or equal.

2.12. TERMINAL Connectors (Fiber Optic)

A. Terminal connectors shall be Type ST2 compatible design with ceramic ferrule and strain relief boot. The epoxy used to attach connectors to the individual fibers shall be a heat cure type featuring an accelerated cure cycle and color change upon cure completion. Connector specifications shall be as follows:

1. Insertion loss (typical): 0.5 dB

2. Durability (mating cycles): 1000 (minimum)

3. Repeatability: Less than 0.2 dB

4. Operating Temperature: minus 40 to plus 80 degrees C

PART 3 EXECUTION

3.01. INSTALLATION

A. Uniquely identify all wires, cables and each conductor of multi-conductor cables (except lighting and receptacle wiring) at each end and in all manholes, hand holes and pull boxes with wire and cable markers.

B. Use lubrications to facilitate wire pulling. Lubricants shall be UL approved for use with the insulation specified.

C. Provide multi-conductor control and signal cables within the underground system. Cables shall be installed continuous from building to building without splices. Individual control conductors and twisted shielded pairs signal cables will not be allowed in underground systems.

D. The crimping tools used in securing the conductor in the compression type connectors or terminal lugs shall be those made for that purpose and for the conductor sizes involved. The crimping tool shall be the ratchet type which prevents the tool from opening until the crimp

action is completed. Such tools shall be a product of the connector manufacturer.

E. Install an equipment grounding conductor in all raceways.

F. Seal openings in slabs and walls through which wires and cables pass.

G. Pull cables from the direction that requires the least tension. Use a feed-in tube and sheave designed for cable installation. Use sheaves with radii that exceed the cable manufacturer's recommended minimum bending radius. Use a dynamometer and constant velocity power puller. Velocity should not be less than 15-ft./min. or more than 50-ft./min. Do not exceed the cable manufacturer's maximum recommended tension.

H. If cable can not be terminated immediately after installation, install heat shrinkable end caps.

I. Fireproof exposed cables in manholes, vaults, pullboxes, switchgear and other areas not protected by conduit where medium voltage cables are present. Use fire-proofing tape and glass tape in accordance with the manufacturer's instructions. Fire-proofing tape shall be installed with one half-lapped layer of Scotch Brand 77 Electric Arc and Fireproofing Tape (3M Corp., or equal). Tape shall be secured with a two-layer band of Scotch Brand 69 Glass Electrical Tape (3M Corp., or equal) over the last wrap.

J. Fiber Optic Cables

1. Provide all material, equipment and labor to install the fiber optic cables indicated and as specified herein.

2. Installation shall be in accordance with the NEC.

3. Install cables in the raceway systems as indicated. Inspect raceways prior to pulling in the cables. Notify the Engineer of any conditions which would prevent installation of the specified cables before proceeding with the installation.

4. Lubricate cables with lubricants specially formulated for fiber cabling jackets during installation. Do not exceed cable manufacturers' specifications for tensile strength and bending radius. Pulleys used to aid in the installation of the fiber optic cable must be sized according to the minimum bending radius. The pulling tension of all fiber cables during installation shall be recorded using a strip recorder. The printout of the strip recorder shall be submitted to the Engineer.

5. For fiber optic cable systems provided under Division 16, provide breakout kits, splice closures, signal transceivers, power supplies, patch panels, pigtails and jumpers to install a complete data highway communications network. Patch panels and splice enclosures shall be wall mounted.

6. Splices shall be made in designated enclosures above ground only. Provide adequate put-up lengths on cable reels to make termination-to-termination runs without splices. Where splices are indicated, provide mechanical splices with attenuation losses of 0.3 dB or less. Make splices watertight and provide mechanical protection equal to the cable jacket.

7. Support cables in riser conduits at intervals as required by the NEC.

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8. Installation tools and materials shall be approved by the cable manufacturer.

9. The polishing process of terminal connectors shall be a two stage wet process using 3.0 micron lapping film for an initial polish followed by 0.3 micron lapping film for the final polish.

10. Label each termination point.

11. Tag each cable in junction boxes, manholes and handholes. Provide permanent nylon/plastic tie-wrap type tags with waterproof markings.

12. Make the following field tests after cable installation:

    a. Visually inspect terminal connectors for out-of-round conditions and surface defects such as micro-chips and cracks using a 100X (minimum) inspection microscope.

    b. Check optical continuity of each fiber from terminal to terminal.

    c. Verify the calculated attenuation power losses of each fiber from the transmit and receive terminals at the source of each data communications loop. The light source and operating wavelength of the test equipment shall be representative of the actual operating equipment.

3.02. WIRE COLOR CODE

A. All wire shall be color coded or coded using electrical tape in sizes where colored insulation is not available. Where tape is used as the identification system, it shall be applied in all junction boxes, manholes and other accessible intermediate locations as well as at each termination.

B. The following coding shall be used:

| System | Wire | Color |
|---|---|---|
| 240/120 Volts Single-Phase, 3 Wire | Neutral | White |
| | Line 1 | Black |
| | Line 2 | Red |
| 208Y/120, Volts 3 Phase, 4 Wire | Neutral | White |
| | Phase A | Black |
| | Phase B | Red |
| | Phase C | Blue |
| 240/120 Volts 3 Phase, 4 Wire delta, center tap ground on phase coil A-C | Neutral | White |
| | Phase A | Black |
| | Phase B (High) | Orange |
| | Phase C | Blue |
| 480Y/277 Volts 3 Phase, 4 Wire | Neutral | White |
| | Phase A | Brown |
| | Phase B | Orange |
| | Phase C | Yellow |

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C. Neutral or ground wires that terminate in a Panelboard and require color tape shall have the color tape extend at least 6-in from the termination point.

3.03. TERMINATIONS AND SPLICES

A. Power conductors: Unless otherwise indicated on the Drawings, no splices may be made in the cables without prior written approval of the Engineer. Where splicing is approved, terminations shall be die type or set screw type pressure connectors as specified. Splices (where allowed) shall be die type compression connector and waterproof with heat shrink boot or epoxy filling for copper conductors # 4 AWG and larger. Splices shall be solderless pressure connectors with insulating covers for copper conductors # 6 AWG and smaller. Aluminum conductors (where specified) shall employ terminations and splices specifically designed for aluminum conductors.

B. Control Conductors: Termination on saddle-type terminals shall be wired directly with a maximum of two conductors. Termination on screw type terminals shall be made with a maximum of two spade connectors. Splices (where allowed) shall be made with insulated compression type connectors.

C. Instrumentation Signal Conductors (including graphic panel, alarm, low and high level signals): terminations same as for control conductors. Splices allowed at instrumentation terminal boxes only.

D. Except where permitted by the Engineer no splices will be allowed in manholes, handholes or other below grade located boxes.

E. Splices shall not be made in push button control stations, control devices (i.e., pressure switches, flow switches, etc), conduit bodies, etc.

3.04. INSTRUMENTATION CABLES

A. Instrumentation cables shall be installed in rigid steel raceways as specified. All circuits shall be installed as twisted pairs or triads. In no case shall a circuit be made up using conductors from different pairs or triads. Triads shall be used wherever three wire circuits are required.

B. Terminal blocks shall be provided at all instrument cable junction and all circuits shall be identified at such junctions.

C. Shielded instrumentation wire, coaxial, data highway, I/O and fiber optic cables shall be run without splices between instruments, terminal boxes, or panels.

D. Ground shielding on instrumentation wires at one end only as recommended by the instrument manufacturer and isolated at all other locations. Terminal blocks shall be provided for inter-connecting shield drain wires at all junction boxes. Where individual circuit shielding is required, each shield circuit shall be provided with its own block.

E. Install shielded instrumentation wire in conduit and pull boxes that contain only shielded instrumentation wire. Instrumentation cables shall be separated from all other (i.e. power, control, etc.) cables in manholes by enclosing them within rigid steel raceways and boxes.

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F. Shielded cable terminations at each end shall be provided with heat shrinkable tubing placed over the exposed shield and conductors. The tubing shall extend 1-in minimum over the jacket end and extend 0.5-in minimum from the jacket end over the exposed conductors.

3.05. FIELD TESTING

A. Test all 600 Volt wire insulation with a megohm meter after installation and prior to termination. Make tests at not less than 1000 Volts DC. Test duration shall be one minute. Submit a written test report of the results to the Engineer. Notify the Engineer in writing 48 hours prior to testing.

B. Field testing and commissioning shall be done in accordance with the latest revision of the "Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems" published by the International Electrical Testing Association (NETA Standard ATS-1999)unless otherwise modified by this Section. Minimum wire insulation resistance shall not be less than 250 Megohms.

END OF SECTION

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SECTION 16141

WIRING DEVICES

PART 1 PART 1 GENERAL

1.01. 1.01 SCOPE OF WORK

A. Furnish all labor, materials, equipment and install wiring devices as shown on the Drawings and as specified herein.

B. Provide all interconnecting conduit and branch circuit wiring for receptacle circuits in accordance with the NEC.

1.02. REFERENCE STANDARDS

A. Wiring devices shall comply with the requirements of the National Electric Code (NEC) and shall be Underwriters Laboratories (UL) labeled.

PART 2 PART 2 PRODUCTS

2.01. MATERIALS

A. Wall switches shall be heavy duty, specification grade, toggle action, flush mounting quiet type. All switches shall conform to the latest revision of Federal Specification WS 896. Wall switches shall be suitable for the area classification indicated and shall be of the following types and manufacturer:

1. Single pole, 20 Amp, 120/277 Volt - Cooper Wiring Devices; Hubbell Wiring Devices-Kellems; Pass & Seymour, Inc. or equal.

2. Double pole, 20 Amp, 120/277 Volt - Cooper Wiring Devices; Hubbell Wiring Devices-Kellems; Pass & Seymour, Inc. or equal.

3. Three way, 20 Amp, 120/277 Volt - Cooper Wiring Devices, Hubbell Wiring Devices-Kellems; Pass & Seymour, Inc. or equal.

4. Four way, 20 Amp, 120/277 Volt - Cooper Wiring Devices; Hubbell Wiring Devices-Kellems; Pass & Seymour, Inc. or equal.

B. Receptacles shall be heavy duty, specification grade of the following types and manufacturer or equal. Receptacles shall conform to Fed Spec WC596-F.

1. Duplex, 20 Amp, 125 Volt, 2 Pole, 3 Wire; Cooper Wiring Devices; Hubbell Wiring Devices-Kellems; Pass & Seymour, Inc. or equal.

2. Weatherproof/corrosion resistant single, 20 Amp, 125 Volt, 2 Pole, 3 Wire, with cover; Crouse-Hinds Co., "weatherproof while in use"; Appleton Electric; Pass & Seymour or equal.

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3. Weatherproof/corrosion resistant duplex, 20 Amp, 125 Volt, 2 Pole, 3 Wire, with cover; Crouse-Hinds Co "weatherproof while in use"; Appleton Electric; Pass & Seymour or equal.

4. Ground fault interrupter, duplex, 20 Amp, 125 Volt, 2 Pole, 3 Wire, GFCI feed thru type with "test" and "reset" buttons. Cooper Wiring Devices; Hubbell Wiring Devices-Kellems; Pass & Seymour, Inc. or equal.

C. Device Plates

1. Plates for indoor flush mounted devices shall be of the required number of gangs for the application involved and shall be as follows:

a. Administration type buildings: Smooth, high impact nylon of the same manufacturer and color as the device. Final color shall be as selected by the Architect.

b. Where permitted in other areas of the plant, flush mounted devices in cement block construction shall be Type 302 high nickel (18-8) stainless steel of the same manufacturer as the devices.

2. Plates for indoor surface mounted device boxes shall be cast metal of the same material as the box, Crouse-Hinds No. DS23G and DS32G; Appleton FSK1DRC, FSK1TSEC; Pass & Seymour or equal.

PART 3 EXECUTION

3.01. INSTALLATION

A. Switch and receptacles outlets shall be installed flush with the finished wall surfaces in areas with stud frame and gypsum board construction, in dry areas with cement block construction or when raceways are shown as concealed on the Drawings.

B. Do not install flush mounted devices in areas designated DAMP, WET or WET/CORROSIVE on the Drawings. Provide surface mounted devices in these areas.

C. Provide weatherproof devices covers in areas designated WET or WET/CORROSIVE on the Drawings.

D. Convenience outlets shall be 15-in above the floor unless otherwise required.

E. Convenience outlets installed outdoors and in rooms where equipment may be hosed down shall be 18-in above floor or grade.

F. Switches and dimmer controls for lighting shall be mounted 48-in above the finished floor unless otherwise noted or required.

G. The location of all devices is shown, in general, on the Drawings and may be varied within reasonable limits so as to avoid any piping or other obstruction without extra cost, subject to the approval of the Engineer. Coordinate the installation of the devices for piping and equipment clearance.

END OF SECTION

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SECTION 16191

MISCELLANEOUS EQUIPMENT

PART 1 GENERAL

1.01 SCOPE OF WORK

A. Furnish and install all miscellaneous equipment as shown on the Drawings and as specified herein.

1.02 EQUIPMENT LIST

A. This Section provides the requirements for miscellaneous equipment typically employed in a facility, however, not all components specified in this Section are necessarily utilized on this project.

PART 2 PRODUCTS

2.01. MATERIALS

A. Disconnect Switches

1. Disconnect switches shall be heavy-duty, quick-make, quick-break, visible blades, 600 Volt, 3 Pole with full cover interlock, interlock defeat and flange mounted operating handle. All current carrying parts shall be copper

2. NEMA 4 enclosures shall be stainless steel.

3. NEMA 4X enclosures shall be stainless steel.

4. Switches shall be as manufactured by the Square D Co.; General Electric; Cutler-Hammer, or equal.

B. Fused Disconnect Switches

1. Fused disconnect switches shall be heavy-duty, quick-make, quick-break, visible blades, 600 Volt, 3 Pole with full cover interlock, interlock defeat and flange mounted operating handle. All current carrying parts shall be copper.

2. Fuses shall be rejection type, 600 Volts, 200,000 A.I.C., dual element, time delay, Bussman Fusetron, Class RK-5 or equal.

3. NEMA 4 enclosures shall be stainless steel.

4. NEMA 4X enclosures shall be stainless steel.

5. Switches shall be as manufactured by the Square D Co.; General Electric; Cutler-Hammer, or equal.

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C. Horsepower Rated, Toggle Switch Type Disconnect Switch

1. Toggle type disconnect switches shall be manufactured of thermoplastic materials with screw-type terminals. The switches shall be rated 600 VAC and 20A at 600 VAC.

2. Toggle type disconnect switches shall be similar to a manual non-reversing starter without overloads and shall be 3 Pole, capable of "on-off" control of a 10 horsepower motor at 460 VAC.

3. Enclosure shall be provided with lock off provisions.

4. NEMA 4 enclosures shall be die-cast zinc.

5. Switches shall be as manufactured by the Square D Co.; Siemens Electrical Products; Cutler-Hammer or equal.

D. Combination Magnetic Motor Starters

1. Motor starters shall be a combination motor circuit protector and contactor, 2 or 3 Pole, single or 3 Phase as required, 60 Hz, 600 Volt, magnetically operated, full voltage non-reversing unless otherwise shown on the Drawings. NEMA sizes shall be as required for the horsepowers shown on the Drawings. Minimum size shall be NEMA size 1. Motor circuit protectors shall be molded case with adjustable magnetic trip only. They shall be specifically designed for use with magnetic motor starters. Motor circuit protectors shall be current limiting type, with additional current limiters if required.

2. Each motor starter shall have a 120 Volt operating coil and control power transformer. Transformer primaries and secondaries shall be equipped with time-delay fuses. Three phase starters shall have three overload relays. One normally open and one normally closed auxiliary contact shall be provided as spares in addition to contacts shown on the Drawings.

3. Overload relays shall be adjustable, ambient compensated and manually reset.

4. NEMA 4 enclosures shall be stainless steel.

5. NEMA 4X enclosures shall be stainless steel.

6. Combination magnetic motor starters shall be as manufactured by the Square D Co.; General Electric; Cutler-Hammer, or equal.

E. General Purpose Dry Type Transformers

1. Transformers shall be dry type, two-winding with kVA and voltage ratings as shown on the Drawings. Transformer shall incorporate a 220 degree C insulation system and be designed not to exceed 150 degrees C temperature rise above a 40 degree C ambient full load

2. Four full capacity taps shall be furnished, two 2-1/2 percent above and two 2-1/2 percent below rated primary voltage.

3. Windings shall be copper.

4. Transformers shall be built in accordance with ANSI C89.2 and NEMA ST-20 shall be UL listed and suitable for non-sinusoidal current loads with a K-factor of 4.

5. Transformers, other than K-rated units, shall meet the efficiency levels contained in Tables 4.1 and 4.2 of NEMA Standard TP1-1996 and shall contain an EPA "Energy Star" label. Efficiency shall be tested in accordance with TP1-1996.

6. Transformers shall have common core construction with low hysteresis and eddy current losses. The core flux density shall be below the saturation point to prevent overheating caused by harmonic distortion.

7. Transformer impedance shall be a minimum of 3 percent and a maximum of 5 percent.

8. Provide vibration isolators for transformers rated 112.5 kVA and higher.

9. Provide ground lug on frame and strap ground core assembly to frame of enclosure.

10. The neutral bus shall be sized and configured for 200 percent of secondary full load current.

11. Transformers shall be manufactured by Square D Co.; General Electric Co.; Cutler-Hammer, or equal.

F. Transformer-Panel Assembly

1. Manufacturers

   a. Cutler-Hammer, Mini-Power Center

   b. Square D, Mini-Power Zone

   c. General Electric, Servicenter

   d. or equal

2. Ratings

   a. kVA and voltage ratings shall be as shown on the Drawings.

   b. Units shall be designed for continuous operation at rated kVA, for 24 hours a day, 365 days a year operation, with normal life expectancy as defined in ANSI C57.96.

   c. Transformer sound levels shall not exceed the following ANSI and NEMA levels for self-cooled ratings.

3. Construction

   a. Each TPA shall include a main primary breaker, an encapsulated dry-type transformer, and a secondary panelboard with main breaker.

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b. Main primary, secondary, and feeder breakers shall be enclosed with a padlockable hinged door.

4. Bus

a. Panelboard bus shall be copper sized to NEMA 65 degrees C rise.

5. Wiring/Terminations

a. All interconnecting wiring between the primary breaker and transformer, secondary main breaker and transformer, and distribution section shall be factory installed.

b. All transformers shall be equipped with a wiring compartment suitable for conduit entry and large enough to allow convenient wiring.

6. Main Devices

a. Each TPA shall include a main primary breaker with an interrupting rating of 22 kA at 480 Volts; and a secondary panelboard with main breaker rated 10 kA interrupting rating at 240 Volts.

7. Feeder Devices

a. The secondary distribution section shall accommodate one inch, bolt-on breakers with 10 kA interrupting capacity.

8. Enclosure

a. he enclosure shall be made of heavy-gauge steel and the maximum temperature of the enclosure shall not exceed 90 degrees C.

b. The enclosure shall be totally enclosed, non-ventilated, NEMA Type 3R, with lifting eyes.

G. Transient Voltage Surge Suppressors (TVSS) as indicated on the Drawings

1. TVSS unit shall be a hybrid device utilizing a linear array of balanced MOV (Metal Oxide Varistors) and a series assembly of silicon avalanche diodes.

2. The TVSS unit shall be tested and labeled in accordance with the following standards: ANSI/IEEE C62.41, Recommended Practice for Surge Voltages in Low-Voltage AC Power Circuits, Category C; ANSI/IEEE C62.45, Guide on Surge Testing for Equipment Connected to Low-Voltage AC Power Circuits; NEMA LS-1 (1992), Low-Voltage Surge Protective Devices; UL 1449-Current Edition; UL 1283 for noise attenuation devices and NEC Article 285.

3. Unit shall have:

a. Parallel Line-Neutral, Line-Ground and Neutral-Ground connection configuration.

b. One Nanosecond or less response time.

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c. Extend noise filtration with a 10 kHZ to 100 MHZ range.

d. Fused internal disconnect switch with 60 Amps, 300,000 AIC rating.

e. Surge current rating of 100,000 Amps per mode at service entrance

f. Surge current rating of 80,000Amps per mode at distribution panels

g. Surge current rating of 65,000Amps per mode at branch panels

h. LED indications

i. Six digit surge counter

j. Form C output contacts

k. System voltage shall be 120/240 grounded neutral, 120/208 grounded wye, 277/480 grounded wye, 240 delta, or 480 delta as indicated on the Drawings

l. NEMA 4 enclosure (steel type)

m. The Maximum Continuous Operating Voltage (MCOV) for all voltage configurations shall be 125 percent of nominal or greater.

n. The fusing system shall be capable of allowing the rated maximum surge current to pass through without fuse operation.

o. TVSS devices at distribution panels or switchboards shall be mounted integral to the equipment with leads as short as possible (not to exceed 24-in) and the lead size shall be a minimum of 6 AWG or larger. The TVSS shall include an integral disconnect switch which has been tested to the surge current rating of the TVSS and shall match or exceed the fault current rating of the board. The disconnect switch shall switch the phases and neutral.

p. TVSS devices at branch panels shall be direct bus-to-bus connected with leads as short as possible (not to exceed 24-in) and lead size shall be a minimum of 6 AWG or larger.

4. TVSS shall be Model PDX3 as manufactured by United Power Corporation; Transtector Systems; Current Technology or equal.]

H. Wireway

1. NEMA 1 wireway shall be painted steel with screw covers.

2. NEMA 4 and 4X wireway shall be stainless steel with gasketed screw covers and stainless steel screws.

3. NEMA 1 wireway shall be Square-Duct as manufactured by the Square D Co.; NEMA 4 and 4X shall be Bulletin F-22 as manufactured by the Hoffman Engineering Co.; Appleton; Killark, or equal.

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I. Control Relays

1. Control relays shall be heavy duty machine tool type, with 10 Amp, 300 Volt convertible contacts. Number of contacts and coil voltage shall be as shown on the Drawings. General use relays shall be General Electric Co., Catalog No. CR120B; similar by Square D Co.; Allen-Bradley Co., or equal. Latching relays shall be General Electric Co., Catalog No. CR120BL; similar by Square D Co.; Allen-Bradley Co. or equal.

2. Time delay relays shall be pneumatic, 600 Volt, 20 Amp contacts, with calibrated knob operated adjustment. On delay and off delay types and timing ranges shall be as shown on the Drawings. Relays shall be Agastat Model 7012 or 7022; similar by Square D Co.; Cutler-Hammer, or equal.

J. Detectable Warning Tape

1. Each duckbank section shall be marked by means of a detectable warning tape (tracer tape) as shown on the Drawings. The detectable warning tape shall be capable of being detected or located by either conductive or inductive location techniques.

2. The detectable warning tape shall consist of 5 mil (.005-in) overall thickness; five-ply composition; ultra-high molecular weight; virgin polyethylene; acid; alkaline and corrosion resistant; with 150 pounds of tensile break strength minimum per 6-in width.

3. The top side of the tracer tape shall be color banded red for electrical and high voltage lines, and orange for signal, communication, telephone and fire alarm lines. Tracer tape shall be 4-in wide with four color bands. The tape shall be inscribed with the warning message for the utility such as "CAUTION – ELECTRICAL LINED BURIED BELOW". Tape shall be as manufactured by Mutual Industries, Inc.; Terra Tape, Div. of Reef Industries Inc. or equal.

K. Terminal Blocks

1. Terminal blocks shall be NEMA type rated at 20 amperes minimum, 600 Volt, channel mounted, with tubular screw and pressure plate.

2. Terminal blocks shall be Bulletin 1492 as manufactured by the Allen-Bradley Co.; ABB; Kukla, or equal.

L. Intrinsically Safe Relays

1. Intrinsically safe relays shall be solid state type with 5 Amp output contacts, suitable for use on a 120 Volt, 60 Hz power supply and shall be FM approved for pilot devices in Class I, Division 1, Group D hazardous atmospheres.

2. Intrinsically safe relays shall be Gems Solid State Safe-Pak as manufactured by Gems Sensors, Division of Transamerica Delaval, Inc.; R. Stahl, Inc; MTL Inc., or equal

M. Photocells

1. The photocells shall be suitable for power duty with individual fixtures or for pilot duty with contactors as detailed on the Drawings. Enclosure shall be NEMA 3R or 4. Contacts

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shall be rated for 2,000 watts continuous at 120 Volts. The unit shall turn on at 1.5 footcandles and off at 5.5 footcandles.

2. Photocells shall be Tork, Model 2101; Intematic; Paragon, or equal.

N. Equipment Identification Nameplates

1. All field mounted electrical equipment such as disconnects, push button stations, etc, shall be provided with a weather resistant engraved laminoid equipment identification nameplate screwed or bolted adjacent to the device. Nameplate shall identify the mechanical equipment controlled exactly as shown on the electrical singleline drawings (i.e, P-95 Cooling Water Pump No. 1).

O. Lighting Contactor

1. Lighting contactor shall be of the electrically operated, mechanically held type mounted in NEMA 1, enclosures (except where noted otherwise on the Drawings) with number of poles as noted on the Drawings. Operating coils shall be rated for 120 Volts unless otherwise indicated on the Drawings and shall be for momentary operation. Provide with "Hand Off-Auto" switch on cover where shown on the Drawings.

2. Contactors shall be rated for 20 Amps, 600 VAC and shall be Automatic Switch Co., Bulletin 917 RC, similar by Square D Co.; Cutler-Hammer, or equal.

P. Enclosed Main Circuit Breaker

1. Molded case circuit breaker: 600 Volt, 3 Pole fully rated, insulated case, with integral fully adjustable solid state trip device. Trip device shall be temperature insensitive and have the following characteristics and functions:

   a. Independently adjustable long time pick-up and delay.

   b. Independently adjustable short time pick-up and delay with i2t in and out switch.

   c. Adjustable instantaneous.

   d. Independently adjustable ground fault pick-up and delay.

   e. Trip mode targets for over load, short circuit and ground fault.

   f. Long time pick-up light.

2. Circuit breaker shall be housed in an enclosure and shall have a short circuit rating as shown on the drawings.

   a. NEMA 4 and NEMA 12 enclosures shall be Type 304 stainless steel.

   b. NEMA 4X enclosures shall be Type 304 stainless steel.

3. Circuit breaker shall be service entrance rated.

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4. Circuit breaker shall be furnished with solid neutral and solid ground assemblies.

5. Circuit breaker shall be as manufactured by Square D Co.; General Electric Co.; Cutler-Hammer, or equal.

Q. Arc Flash Protection Warning Signs

1. Provide field-affixed arc flash warning labels on all switchboards, panelboards, industrial control panels, and motor control centers in accordance with National Electrical Code Article 110.16.

2. As a minimum, warning signs shall state "WARNING: Arc Flash and Shock Hazard, Appropriate PPE required", and shall be designed in accordance with ANSI Z535.4-1998. Where available from the equipment manufacturer, additional information including Flash Hazard boundary, incident energy, voltage shock hazard, PPE required, etc. shall be provided.

PART 3 EXECUTION

3.01. INSTALLATION

A. A. Mounting Stands

1. Field mounted disconnects, pushbutton control stations, alarm panels, enclosed starters and circuit breakers, transformers, automatic transfer switches, wireways, contactors, terminal boxes, junction and pull boxes shall be mounted on galvanized or stainless steel stands as specified. Where clearance requirements for stands may not be maintained, the Engineer may direct electric control equipment to be wall-mounted adjacent to the driven equipment, but in no case shall the distance from the drive motor to the control station exceed 3-ft, all at no additional cost to the Owner.

2. Channel supports shall be ground smooth and fitted with plastic end caps.

B. All panelboards located in pedestal cabinets or outdoors and panelboards that have branch circuits feeding exterior to the building shall be equipped with lightning arresters and surge capacitors.

3.02. FIELD TESTING

A. Before supplying power to the alarm panels, the following tests shall be done: Verify that all wiring connection interfaces that are required are present. Check for secure connections. Using a continuity device, verify that all discrete inputs and output to and from the control panel are wired in correct polarity and are operating in the correct state of operation (normally open or closed state). Check for any direct short circuits across all voltage supply sources. As each of the above tests are performed, the Electrical Contractor shall highlight and initial each circuit that is tested. This set of prints shall be signed and left inside the enclosure.

B. Check mechanical interlocks for intended operation. Make any adjustments required.

C. In the event of an equipment fault in the panel, notify the Engineer immediately. After the cause of the fault has been identified and corrected, a joint inspection of the equipment shall be

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conducted by the Contractor and Engineer. Repair or replace the equipment as directed by the Engineer prior to placing the equipment back into service at no additional cost to the Owner.

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SECTION 16425

SWITCHBOARD

PART 1. GENERAL

1.01. SCOPE OF WORK

A. Furnish and install the switchboard as shown on the Drawings and as specified herein.

1.02. REFERENCE STANDARDS

A. Switchboard shall be designed, built, and tested in accordance with the latest editions and revisions NEMA Standard PB-2, and Underwriters' Laboratories (UL) Standard No. UL-891. Switchboard shall also comply with any applicable ANSI and IEEE Standards and the requirements of the National Electric Code (NEC).

B. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.03. QUALITY ASSURANCE

A. The equipment furnished under this Section shall be the product of a manufacturer who has produced this same type of equipment for a period of at least 10 consecutive years.

B. The switchboard[s] shall be designed, assembled and tested by the manufacturer of the circuit protective devices used in the switchboard.

C. Switchboard shall be as manufactured by General Electric Co.; Cutler-Hammer; Square D Co. or equal.

1.04. MANUFACTURERS' SERVICES

A. The switchboard manufacturer shall furnish the services of a factory trained engineer that has complete knowledge of proper operation and maintenance of the equipment furnished under this Section. Services shall be provided for one working day to instruct the Owner on the operation and maintenance of the equipment. This instruction may be done at the same time as the inspection of the installation and field test run provided that: (1) the test is successful and (2) the operating and maintenance manuals have been previously furnished to and approved by the Engineer.

PART 2. PRODUCTS

2.01. RATINGS

A. The switchboard[s] and protective devices shall be fully rated for a short circuit current as shown on the drawings. Systems employing series connected ratings shall not be used. Main and feeder devices shall be coordinated for selective tripping.

B. Switchboard shall be UL listed and labeled as suitable for use as service equipment.

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2.02. CONSTRUCTION

A. Structure

1. Switchboard shall be NEMA classified as shown on the drawings, free standing, front accessible, rear aligned and suitable for against-the-wall mounting. All connections and bus maintenance shall be from the front or the top.

2. Isolated compartments shall be provided for main circuit device and metering equipment.

3. Feeder devices shall be arranged in group mounted construction. Feeder section(s) shall be isolated from main section, and from adjacent feeder sections.

4. Side, top and rear covers shall be code gauge steel, bolted to 12 gauge frame structure members. Front doors shall be flush, hinged, with screw fasteners.

5. All metal surfaces shall be chemically cleaned and primed. The finishing coat of paint shall be ANSI Z55.1 No. 61, light gray enamel.

B. Structure

1. Switchboard shall free standing, rear accessible, completely metal enclosed and sectionalized to isolate and minimize the effects of internal short circuit currents. All sections shall line up front and rear.

2. Completely isolated compartments shall be provided for all main and branch circuit protective devices and metering equipment. Feeder devices shall be individually mounted. Incoming and outgoing cable connections shall be made in the rear of the switchboard.

3. Incoming line compartment shall be isolated from the feeder compartments.

4. Cable compartments shall be isolated from phase bus with barriers.

5. All buses shall be totally enclosed with insulating materials. Bus joints shall have removable insulating covers or boots. Taped buses are not acceptable.

6. Side and top covers shall be code gauge steel, bolted to 12 gauge frame structure members. Front and rear doors shall be flush, hinged, with screw fasteners.

7. Each main and feeder device shall be in individual compartments with an external operating handle located on the compartment front door.

8. Compartments shown on the Drawings as "SPACE" shall be furnished with all hardware necessary for the future addition of a protective device as noted. The equipment shall include but not necessarily be limited to compartment door, barriers, plug-in assembly, line and load bus stubs, etc.

9. All metal surfaces shall be chemically cleaned and primed. The finishing coat of paint shall be ANSI Z55.1 No. 61, light gray enamel.

C. Buses

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1. All buses shall be tin plated aluminum. Neutral bus shall be fully rated.

2. Buses shall be braced for the specified equipment short circuit current rating.

3. All joint connections shall be welded or shall be joined with bolts and Belleville washers.

4. Provide a copper ground bus extending throughout the entire length of the switchboard, equipped with lugs for external ground connections, sized for cables shown on the Drawings.

5. Unused spaces, or spaces indicated for future devices shall include doors, bus, device supports or mounting plates and connections.

D. Main Section

1. The switchboard[s] shall include an auxiliary cable pull section for transition from underground cable feed. Provide bus extensions and compression lugs for number and size of incoming cables as shown on the Drawings.

E. Main Circuit Protective Device

1. Main circuit breaker shall be insulated case, 3 Pole, 600 Volt, 100 percent rated, stationary type, electrically operated with stored energy closing mechanism, General Electric "Power Break" series or equal. Trip device shall be solid state with adjustable long time pickup, delay and timing light; adjustable short time pickup and delay; short time i2t switch; adjustable high range instantaneous, adjustable ground fault pickup and delay; overload, short circuit and ground fault indicator lights, ground fault delay and pickup trips for selective tripping.

2. Main device shall be equipped with contacts for remote status and trip indication. Device rating shall be as shown on the Drawings.

F. Feeder Protective Devices

1. Feeder circuit breakers shall be molded case, 3 Pole, 600 Volt, 100 percent equipment rated, fixed type equipped with an adjustable, temperature insensitive, solid-state, trip device similar by the General Electric Company's "MicroVersa Trip"; Westinghouse "Seltronic", or equal with adjustable instantaneous, short time, long time and ground fault delay and pickup trips for selective tripping.

G. Digital Metering

1. The Digital Metering shall be a microprocessor based, solid state unit, door mounted providing monitoring. The Digital Metering shall comply with ANSI C37.90.

2. The Digital Metering shall provide a digital display of values for the units listed below and shall automatically range between units, kilo-units and mega-units for all displayed values.

   a. AC amperes in each phase, 1 percent accuracy.

   b. AC voltage, phase-to-phase, phase-to-neutral, 1 percent accuracy.

c. Frequency, 0.5 percent accuracy.

3. Current transformers shall be provided.

4. The Digital Metering shall not use voltages greater than 120 VAC. A remote mounted voltage power module and connecting cable or fused potential transformers shall be furnished.

5. The Digital Metering face shall be membrane type and rated NEMA 12. The DM shall have a durable six digit LED display screen. The display screen and LED's shall indicate both trip and alarm conditions. The cause of a trip or alarm shall be indicated in the display window.

6. The Digital Metering shall have an operating temperature range of 0 to 70 degrees C, and 0 to 95 percent relative humidity noncondensing.

7. The Digital Metering shall be Cutler-Hammer IQ Generator or equal.

H. Wiring

1. Low voltage instrument and control wiring shall be copper, Type SIS, flameproof switchboard wire identified with shrink-on marker sleeves at each end. Low voltage wiring terminal blocks shall have marking strips and shall be mounted vertically in an accessible location. All terminal lugs shall be of the full loop type.

I. Marking and Identification

1. Nameplates shall be provided on all hinged doors for unit load description and for each control or indicating device. Nameplates shall be engraved as shown on the Drawing or as directed, using lettering approximately 3/8-in high for unit identification nameplates and 1/4-in high elsewhere. The nameplates shall be black and white laminated phenolic material. The engraving shall extend through the black exterior lamination to the white core. Nameplates shall be screw fastened.

2. A manufacturer's plaque shall be fastened to the front of the switchboard. The plaque shall indicate model number, serial number, amperes, volts, short circuit rating, etc.

## PART 3. EXECUTION

### 3.01. INSTALLATION

A. Switchboards, shall be mounted on continuous 4-in structural steel channels furnished under this Section, set flush with the equipment pad and level in all directions. The switchboard shall be bolted to the channels with not less than 1/2-in bolts. Provide anchor bolts, shims and hardware in accordance with the details shown on the Drawings.

B. Installation shall be in accordance with the manufacturers' instructions.

C. The switchboard shall be arranged so that the uppermost operating handle shall not exceed 6-ft-6-in from the floor when the switchboard is mounted on a 4-in high equipment pad.

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D. Field wiring shall be grouped by circuit and tie wrapped. Terminations shall not be stressed.

3.02. 3.02 FIELD TESTING

A. Make the following minimum tests and checks before energizing the equipment:

1. Megger terminals and buses at two times rated voltage, phase-to-phase and phase-to-ground after disconnecting devices sensitive to megger voltage.

2. Remove all current transformer shunts after completing secondary circuit.

3. Check all mechanical interlocks for proper operation.

4. Vacuum clean all interior equipment.

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SECTION 16431

PAD MOUNTED TRANSFORMER(S)

PART 1 GENERAL

1.01 SCOPE OF WORK

A. Furnish and install the outdoor, liquid filled, pad mounted transformer(s) as shown on the Drawings and as specified herein.

1.02 RELATED WORK

1.03 SUBMITTALS

A. Submit shop drawings and product data, for the following:
   1. Equipment sectional and plan views, bottom plan showing conduit openings and anchor bolt pattern, bushing arrangement, dimensions, weight and construction details.
   2. Winding and core arrangement, materials, ratings and insulation details.
   3. Transformer diagrammatic nameplate information.
   4. Itemized bill of materials for accessories.
   5. Certified shop test reports.
   6. Field test reports.
   7. Installation and maintenance manuals.

1.04 REFERENCE STANDARDS

A. Transformer(s) shall be designed, built and tested in accordance with the following standards:
   1. ANSI C57.12.00 - Standard General Requirements for Liquid-Immersed Distribution, Power and Regulating Transformers.
   2. Western Underground Committee Guide 2.13 for vandal resistance.
   3. NEMA Standard TRI - Transformers, Regulators and Reactors.
   4. IEEE Sta. 462A, B-1978 "Short Circuit Requirements Supplement to ANSI C57.12.00-1973".

B. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.05 QUALITY ASSURANCE

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A. The equipment furnished under this Section shall be the product of a manufacturer who has produced this same type of equipment for a period of at least 10 consecutive years.

B. Transformer(s) shall be designed, assembled and tested by the manufacturer of the core and coil assemblies used in the transformer.

1.06 SYSTEM DESCRIPTION

1.07 DELIVERY, STORAGE AND HANDLING

1.08 PROJECT/SITE REQUIREMENTS

1.09 MAINTENANCE

1.10 WARRANTY

1.11 MANUFACTURERS

A. Acceptable Manufacturers:

1. ABB - ASEA Brown Boveri
2. Cooper Power Systems (RTE)
3. Square D
4. General Electric

PART 2 PRODUCTS

2.01 RATINGS

A. Transformer self cooled kVA rating(s) shall be [ ] kVA. Winding temperature rise shall not exceed 65 degrees C above a 30 degree C average ambient temperature, with a maximum ambient not to exceed 40 degrees C, operating at full rated kVA load.

B. Primary windings shall have the following ratings:

1. Voltage: [ / ] Volts, 3 Phase, 60 Hz
2. Connection: Delta
3. Basic Impulse Level (BIL): [60] [75] [95] [125] [150] [200] kV

C. Secondary windings shall have the following ratings:

1. Voltage: 480Y/277 Volts
2. Connection: Grounded wye

3. Basic Impulse Level (BIL): 30 kV

D. Transformer impedance shall range between 2.6 and 5.4 percent for 500 kVA units and smaller. Impedance of 750 kVA units and above shall be 5.75 percent, subject to ANSI tolerance of plus/minus 7.5 percent.

E. Transformer(s) shall be designed to supply the specified kVA rating without exceeding its nameplate temperature rise, with [redacted] percent connected non-linear type loads. The transformer "K" factor shall be K4 or better.

2.02 CONSTRUCTION

A. Transformer(s) shall be compartmental type, liquid filled, self-cooled, tamper resistant, weatherproof and suitable for mounting on a concrete pad.

B. Transformer tank(s) shall utilize welded steel construction, sealed to withstand an internal pressure of up to 7 psi without distortion, and top oil temperatures ranging from 50 to 105 degrees C. Tank cover shall be designed to permit access to internal components for inspection or repair. Heavy duty, non-removable lifting lugs and jacking pads shall be provided. When required, welded cooling panels or radiators shall be provided on the back and sides of the tank.

C. The high and low voltage compartments shall be located side-by-side separated by a steel barrier. When facing the transformer, the low voltage compartment shall be on the right. Terminal compartments shall be full height, air filled with individual doors. The high voltage door fastenings shall not be accessible until the low voltage door has been opened. The low voltage door shall have a 3-point latching mechanism with vault type handle having provisions for a single padlock. The doors shall be equipped with lift-off type stainless steel hinges and door stops to hold the doors open when working in the compartments. The front sill of the compartment shall be removable to allow the transformer to be rolled or skidded into position over conduit stubs. ANSI tank grounding provisions shall be furnished in each compartment.

D. The core shall be five-legged. Windings and internal leads shall be aluminum, insulated and braced to prevent phase flashovers during fault conditions. Transformers with wye connected primary and secondary windings shall have the primary neutral insulated from the secondary neutral and brought out into the primary compartment through a separate bushing. Both neutral bushings shall be externally connected to the tank with removable copper straps.

E. Transformer insulating oil shall be Exxon Univolt 33 Hydrofined (R) oil, or equal. Insulating oil shall be free of P.C.B. contamination or any E.P.A. listed toxic chemical. The transformer manufacturer shall test the insulating oil for P.C.B. after filling the tank.

F. Furnish a no load, externally operated, lockable, five-position primary winding tap changer located in the secondary terminal compartment. Tap setting must be clearly visible with the compartment door in the open position. Tap adjustments shall be as follows:

1. For 208Y/120 Volt secondary: (4) - 2.5 percent taps below rated primary voltage.

2. For 480Y/277 Volt secondary: (2) - 2.5 percent taps above and below rated primary voltage.

G. Terminations

1. High voltage primary terminations shall be arranged for dead front loop feed and conform to ANSI C57.12.26 requirements. Provide one piece integrated bushings for use with elbow terminators and parking stands for disengaged elbows. Bushings shall be externally clamped to allow external replacement. The transformer manufacturer shall furnish 200 Amp load-break elbows (8.3 kV line-to-ground maximum) elbow terminators for each bushing in accordance with ANSI C119.2.

2. Tie connections between primary loop feed bushings shall be rated for 200 Amps.

3. Low voltage secondary bushings shall be externally clamped, molded epoxy, spade type with NEMA standard four or six hole arrangement. Neutral shall be brought out through an insulated bushing and grounded to the tank wall with a removable grounding strap.

## 2.03 HIGH VOLTAGE PRIMARY SWITCHING AND PROTECTIVE EQUIPMENT

A. Furnish an oil immersed, three phase, gang operated, four position loop feed, load break primary switch, mounted inside the transformer tank. An external, hook stick type switch operator and index plate shall be mounted in the high voltage primary terminal compartment. Switch positions shall be clearly marked. Minimum switch ratings shall be as follows:

1. 15 kV, 200 Amps continuous.

2. Momentary and fault close: 10,000 Amps symmetrical.

3. One minute 60 Hz withstand: 50 kV

B. Furnish three, 1 Pole, 200 Amp, fused air break switches. Fuses shall be current limiting with an interrupting capacity of 50,000 Amps RMS symmetrical. Phase to phase and phase to ground insulating barriers shall be furnished.

C. Primary Fuse Arrangement

1. Provide oil immersed partial range current limiting fuses in series with externally removable Bay-O-Net type expulsion fuses. Fuse mounts shall be dead front, externally removable, hot stick operated, load-break, individual fused disconnect devices, located in the high voltage compartment above the primary bushings to permit fuse replacement without opening the tank. Current limiting fuses shall be accessible through a handhole in the tank cover.

2. The CLF and expulsion fuses shall be properly coordinated such that the CLF protects for fault values above the expulsion fuse interrupting rating, the expulsion fuse protects the CLF for current values below the CLF interrupting capability and the CLF will not operate for low side faults beyond secondary terminals.

D. Lightning Arresters

1. Furnish three 15 kV distribution class lightning arresters mounted in the high voltage primary compartment for surge protection.

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2.04 ACCESSORIES

A. Each transformer shall be furnished with the following accessories:

1. Nameplate in the low voltage compartment.

2. 1-in drain plug (75 to 500 kVA) or 1-in drain valve with sampling device (750 to 5000 kVA).

3. 1-in upper filter press and filling plug.

4. 1-in drain valve with sampling device (75 to 500 kVA).

5. Dial type thermometer with maximum temperature indicator, mounted in a sealed drywell in the low voltage compartment.

6. Auxiliary, sealed, dry contact in thermometer for remote indication of high temperature alarm.

7. Pressure-vacuum gauge mounted in the low voltage compartment.

8. Pressure relief valve.

9. Pressure relief diaphragm.

10. Sudden pressure relay.

11. Magnetic liquid level gauge located in the low voltage compartment at the 25 degree C level mark.

12. Auxiliary, sealed, dry contact in the level gauge for remote indication of low oil level alarm.

13. Mounting provision for voltage and current metering transformers.

2.05 SURFACE PREPARATION AND SHOP COATINGS

A. All welds shall be ground smooth and all metal surfaces cleaned of oil, grease and weld spatter using a hot phosphate chemical treatment. A zinc-rich, heat cured epoxy primer shall be applied to inhibit rust.

B. The equipment shall receive an intermediate coat of heat cured epoxy finish color, followed by an air dried finish coat of Outdoor green, Munsell No. 7GY3.29/1.5.After finish painting, all bottom surfaces, and sides up to a minimum of 1-in above the ground shall be protected against corrosion by an epoxy tar coating.

2.06 SHOP TESTING

A. Perform manufacturers standard production testing and inspection in accordance with ANSI Test Code C57.12.90 and/or NEMA TR1. Testing shall include the following as a minimum:

1. Resistance measurements of all windings on the rated voltage connection of each unit and at the tap extremes of one unit only of a given rating on this project.

2. Ratio tests on the rated voltage connection and on all tap connections.

3. Polarity and phase-relation tests on the rated voltage connections.

4. No-load loss at rated voltage on the rated voltage connection.

5. Exciting current at rated voltage on the rated voltage connection.

6. Impedance and load loss at rated current on the rated voltage connection of each unit and on the tap extremes of one unit only of a given rating on this project.

7. Temperature Test or tests shall be made on one unit only of a project covering one or more units of given rating. Tests shall not be required when there is available a record of a temperature test on an essentially duplicate unit.

8. Applied potential test.

9. Induced potential tests.

10. Toxic chemical (e.g. P.C.B.) test.

11. Short circuit capability of transformer design.

B. Manufacturer shall certify compliance with transformer coating performance per ANSI C57.12.28.

C. Results of the above tests including no load loss data shall be submitted with final drawings in the form of certified test reports.

PART 3 EXECUTION

3.01 PREPARATION

3.02 INSTALLATION

A. The equipment shall be leveled and anchored directly to a concrete equipment pad as shown on the Drawings. Provide hardware and metal shims for installation. Anchor bolts shall be 1/2-in galvanized steel.

B. Install the equipment in accordance with the manufacturer's instructions.

C. Remove temporary packing and shipping braces. Touch-up damaged paint finishes.

3.03 FIELD TESTING

A. Engage the services of an independent testing firm to inspect and test the installed equipment prior to energization. The testing firm shall provide all material, labor, equipment and technical

supervision to perform the tests and inspection. Notify the Owner/Engineer at least 2 weeks prior to scheduling any testing.

B. Equipment testing and inspection shall be performed in accordance with NETA Standard ATS and shall include the following:

1. Visual and mechanical inspection.

2. Ground resistance test.

3. Insulation resistance tests, winding-to-winding and winding-to-ground, using a megohmmeter, at nominal tap position with all cables disconnected.

C. In the event of an equipment fault, notify the Owner/Engineer immediately. After the cause of the fault has been identified and corrected, a joint inspection of the equipment shall be conducted by the Contractor, the Owner/Engineer and the equipment manufacturer's factory service technician. Repair or replace the equipment as directed by the Owner/Engineer prior to placing the equipment back into service.

3.04 ADJUSTMENT

3.05 CLEANING

A. Remove all rubbish and debris from inside and around the equipment. Remove dirt, dust, or concrete spatter from the interior and exterior of the equipment using brushes, vacuum cleaner, or clean, lint-free rags. Do not use compressed air.

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SECTION 16470

PANELBOARDS

PART 1 GENERAL

1.01. SCOPE OF WORK

A. Furnish all labor, materials, equipment and incidentals required and install all panelboards as shown on the Drawings and as specified herein.

1.02. REFERENCE STANDARDS

A. Panelboards shall be in accordance with the Underwriter Laboratories (UL) "Standard for Panelboards" and "Standard for Cabinets and Boxes" and shall be so labeled where procedures exist. Panelboards shall also comply with NEMA Standard for Panelboards and the National Electrical Code (NEC).

B. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.03. MANUFACTURERS

A. 120/240 Volt, single phase, 3 Wire and 120/208 Volt, 3 Phase, 4 Wire panelboards shall be Sentron Type P1 as manufactured by Siemens; Type NQOD by Square D Co.; Type Pow-R-Line C by Cutler-Hammer; or Type AQ as manufactured by the General Electric Co.

B. 277/480 Volt, 3 Phase, 4 Wire panelboards shall be Sentron Type P1or P2 as manufactured by Siemens; Type NF by Square D Co.; Type Pow-R-Line C by Cutler-Hammer or Type AE as manufactured by the General Electric Co.

C. 480 Volt, 3 Phase, 3 Wire Power panelboards shall be Sentron Type P3 as manufactured by Siemens; Type NF by Square D Co.; Type Pow-R-Line C by Cutler-Hammer; or Type AD by General Electric Co.

D. 480 Volt, 3 Phase, 3 Wire Distribution panelboards shall be Sentron Type P4 or P5 as manufactured by Siemens; I-Line series by Square D Co. or Spectra Series by General Electric Co.; Type Pow-R-Line C by Cutler-Hammer, or equal.

E. NEMA 3, 4 and 12 panelboards shall be similar to those specified above with appropriate enclosure modifications as required by voltage application. Panel enclosures shall be provided as specified in Section 16000 and 16110.

PART 2 PRODUCTS

2.01. GENERAL

A. Rating

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1. Panelboard ratings shall be as shown on the Drawings. All panelboards shall be rated for the intended voltage.

2. Circuit breaker panelboards shall be fully rated for the specified circuit breaker fault current interrupting capacity. Series connected short circuit ratings will not be acceptable.

2.02. MATERIALS (NEMA 1)

A. Interiors

1. All interiors shall be completely factory assembled with circuit breakers, wire connectors, etc. All wire connectors, except screw terminals, shall be of the anti-turn solderless type and all shall be suitable for copper or aluminum wire of the sizes indicated.

2. Interiors shall be so designed that circuit breakers can be replaced without disturbing adjacent units and without removing the main bus connectors and shall be so designed that circuits may be changed without machining, drilling or tapping.

3. Branch circuits shall be arranged using double row construction except when narrow column panels are indicated. Branch circuits shall be numbered by the manufacturer.

4. A nameplate shall be provided listing manufacturer's name, panel type and rating.

B. Buses

1. Bus bars for the mains shall be of copper. Full size neutral bars shall be included. Phase bussing shall be full height without reduction. Cross connectors shall be copper.

2. Neutral bussing shall have a suitable lug for each outgoing feeder requiring a neutral connection.

3. Spaces, provision for future breakers, shall have bus straps bolted onto the bus so that future breakers can be bolted into the panel.

4. Equipment ground bars shall be furnished.

C. Boxes

1. Recessed or flush mounted boxes shall be made from galvanized code gauge steel having multiple knockouts, unless otherwise noted. Boxes shall be of sufficient size to provide a minimum gutter space of 4-in on all sides.

2. Surface mounted boxes and trims shall have an internal and external finish as specified in Paragraph 2.04D4 below. Surface mounted boxes shall be field punched for conduit entrances.

3. At least four studs for mounting the panelboard interior shall be furnished.

D. Trim

1. Hinged doors covering all circuit breaker handles shall be included in all panel trims.

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2. Doors shall have semi flush type cylinder lock and catch, except that doors over 48-in in height shall have a vault handle and 3-point catch, complete with lock, arranged to fasten door at top, bottom and center. Door hinges shall be concealed. Furnish two keys for each lock. All locks shall be keyed alike; directory frame and card having a transparent cover shall be furnished on each door.

3. The trims shall be fabricated from code gauge sheet steel.

4. All exterior and interior steel surfaces of the panelboard shall be properly cleaned and finished with ANSI Z55.1, No. 61 light gray paint over a rust-inhibiting phosphatized coating. The finish paint shall be of a type to which field applied paint will adhere.

5. Trims for flush panels shall overlap the box by at least 3/4-in all around. Surface trims shall have the same width and height as the box. Trims shall be fastened with quarter turn clamps.

6. Door-in-door type construction shall be provided so that trim may be opened to access wire ways without removing the trim from the panel

2.03. CIRCUIT BREAKERS

A. Panelboards shall be equipped with circuit breakers with frame size and trip settings as shown on the Drawings.

B. Circuit breakers shall be molded case, bolt-in type.

C. Circuit breakers shall be as manufactured by the panelboard manufacturer.

PART 3 EXECUTION

3.01. INSTALLATION

A. Mount boxes for surface mounted panelboards so there is at least 1/2-in air space between the box and the wall.

B. Connect panelboard branch circuit loads so that the load is distributed as equally as possible between the phase busses.

C. Type circuit directories giving location and nature of load served. Install circuit directories in each panelboard.

D. Install markers on the front cover of all panelboards which identify the voltage rating. Markers shall be made of self sticking B-500 vinyl cloth printed with black characters on an Alert Orange background, 2-1/4-in high by 9-in wide, Style A as manufactured by W.H. Brady Co. or equal.

E. Install a 1-in by 3-in laminated plastic nameplate with 1/4-in white letters on a black background on each panelboard. Nameplate lettering shall be as shown on the Drawings. Nameplates shall be stainless steel screw mounted.

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SECTION 16481

18 PULSE VARIABLE FREQUENCY DRIVE CONTROLLERS (PWM)

PART 1 GENERAL

1.01. SCOPE OF WORK

A. Provide labor, equipment, supervision and materials for the installation, testing and start-up of 18-pulse Variable Frequency Drive controllers (VFD) with Motor Protection Filters and 5% Input Line Reactors as shown on the Drawings and as specified herein.

B. Provide a factory trained technician to start-up each VFD. The technician shall be present during the field acceptance testing. Start-up service shall include overtime charges, travel and living expenses and replacement parts.

C. Provide 8 hours of on-site instructions on VFD operation for the Owner's personnel.

D. The VFD manufacturer shall verify that the motor to be used is suitable for use with the VFD. Size VFD at 125% of motor FLA.

1.02. REFERENCE STANDARDS

A. IEEE Standard 519 - "Guide for Harmonic Control and Reactive Compensation of Static Power Converters."

B. National Electrical Code (NFPA 70)

C. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.03. QUALITY ASSURANCE

A. Variable frequency drives shall utilize a field proven design. The VFD manufacturer shall demonstrate at least 3 years of continuous field operating experience with equipment of similar size and design.

B. A factory authorized service and parts organization shall be located within 100 miles of the project location. Provide the name and address of the factory authorized service and parts organization nearest to the project location at the time of the bid.

C. Equipment shall be UL or ETL labeled.

1.04. SYSTEM DESCRIPTION

A. Refer to the driven equipment specifications for description of system operation.

1.05. DELIVERY, STORAGE AND HANDLING

A. Package the equipment for maximum protection during delivery and storage.

B. Store the equipment indoors in a clean, dry, heated storage facility until ready for installation. Do not install the equipment in its final location until the facilities are permanently weather tight. Furnish, install and wire temporary electric space heaters in the equipment until the permanent heating equipment is operational. Protect the equipment at all times from exposure to moisture, chemicals, hydrogen sulfide and chlorine gas.

PART 2 PRODUCTS

2.01. RATING

A. Service Conditions

1. Input power: Voltage as shown plus 10 percent, minus 5 percent, 3 Phase, 60 Hz.

2. Input frequency: 57 to 63 Hz.

3. Ambient temperature: 0 to 40 degrees C.

4. Elevation: Up to 3300-ft above mean sea level.

5. Relative humidity: Up to 90 percent non condensing.

B. Minimum drive efficiency: 97 percent or better at 4/4 motor base speed and rated torque.

C. Displacement power factor: 95 percent or higher throughout the entire speed range, measured at drive input terminals.

D. Drive output: 100 percent rated current continuous, suitable for operation of the driven equipment over the required speed range without overloading. Drives shall be capable of a continuous overload up to 110 percent rated current for variable torque loads and 150 percent rated current for constant torque loads. Starting torque shall be matched to the load.

E. Voltage regulation: plus or minus 1 percent of rated value, no load to full load.

F. Output frequency drift: No more than plus or minus 0.5 percent from setpoint.

G. Drives shall withstand five cycle transient voltage dips of up to 15 percent of rated voltage without an undervoltage trip or fault shutdown, while operating a variable torque load.

2.02. CONSTRUCTION

A. General

1. The general arrangement of the equipment is shown on the Drawings. All drives shall be furnished by the same manufacturer.

2. The VFDs shall utilize a digital pulse width modulated (PWM) design to convert the fixed AC input to a variable voltage, variable frequency AC output. Construction shall be modular, using plug-in type component mounting or keyed ribbon cable connections wherever possible to minimize downtime during repair.

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3. The VFD operate satisfactorily when connected to a bus supplying other solid state power conversion equipment which may be causing up to 10 percent total harmonic voltage distortion and commutation notches up to 36,500 volt microseconds, or when other VFD's are operating from the same bus. The drive shall include transient voltage suppression to allow reliable operation on a typical commercial power distribution system.

4. The VFD shall consist of a full-wave diode bridge converter to convert incoming fixed voltage/frequency to a fixed DC voltage. Provide a DC link choke smoothing reactor to limit fault throughput. The PWM strategy shall be of the space-vector type implemented through a microprocessor which generated a sinecoded output voltage.

5. The output shall be generated by power transistors which shall be controlled by six identical, optically isolated base driver circuits. The VFD shall have an output voltage regulator to maintain correct output Volt/Hz despite incoming voltage variations. The VFD shall have a continuous output current rating equal to or greater than the motor full load nameplate current.

6. Provide 5% Input Line Reactor for each 18-Pulse VFD specified herein. Provide Motor Protection Filter for each drive (TCI or equal.).

B. Features and Options

1. Each VFD shall have a molded case, circuit breaker type main power disconnect switch, with an external operating handle. The circuit breaker shall have a short circuit rating of 65,000 Amps, RMS symmetrical and shall be labeled in accordance with UL 489.

2. Provide the following safety features:

   a. Provision to padlock main disconnect handle in the OFF position.

   b. Mechanical interlock to prevent opening cabinet door with disconnect in the ON position, or moving disconnect to the ON position while the unit door is open.

   c. Barriers and warning signs on terminals that are energized with the power disconnect OFF.

3. Provide an equipment ground bus or lug connectors in each enclosure, suitable for connection to the copper grounding conductors shown on the Drawings.

C. Operator interface

1. Provide a door-mounted digital keypad/display, capable of controlling the drive and setting drive parameters. The digital display shall normally display:

   a. Speed demand in percent

   b. Output current in amperes

   c. Frequency in Hz

   d. Control mode - manual or automatic

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2. The digital keypad shall allow operators to enter exact numerical settings in English engineering units. A user menu shall be provided as a guide to parameter settings. Coded messages on keypad will not be acceptable. Parameters are to be factory set in EEPROM and resettable in the field. Parameters shall be password protected. The EEPROM stored variables shall be transferable to new and spare boards.

3. The keypad/display module shall have a key switch to control operation of the keypad. The key shall be removable in either the "Enabled" or "Disabled" positions. The keypad module shall contain a "self-test" software program that can be activated to verify proper keypad operation. The keypad display shall contain a full alphanumeric character set.

4. The following controls and indicators shall be provided, either separately or as part of the keypad/display:

   a. POWER ON, RUN AND FAULT indication.

   b. FAULT RESET control.

   c. MANUAL-AUTO control mode selector.

   d. Manual START/STOP controls.

   e. Manual speed adjust capability.

D. Auxiliary Contacts

1. Provide one set of Form C auxiliary dry contacts for remote indication of VFD running status.

2. Provide set of Form C auxiliary dry contacts for remote indication of VFD fault.

E. Marking and Identification

1. Provide 1-in by 3-in, nominal, engraved lamicoid equipment nameplates on each VFD fastened with stainless steel screws or rivets. Nameplates shall be black with white core, 3/8-in high lettering.

2. Provide permanent warning signs as follows.

   a. "Warning-Hazard of Electric Shock - Disconnect power before opening or working on this unit" on main power disconnect.

## 2.03. PROTECTIVE AND OPERATIONAL FEATURES

A. Make provisions for field adjustment of the following parameters through the keypad/display:

1. Current limit and boost.

2. Voltage (Volts/Hz)

3. Frequency (Minimum/Maximum)

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4. Independently adjustable acceleration and deceleration rates.

5. Auto restart delay.

B. Make provisions to accept a remote dry contact closure to start and stop the drive(s) with the drive control system in the AUTO mode.

C. Make provisions to accept a 4-20 mADC input signal for remote speed control. Input shall be isolated at the drive and active with the drive control system in the AUTO mode. Zero and span adjustability shall be provided.

D. Provide a 4-20 mADC isolated output signal proportional to speed for remote speed indication.

E. Provide the following short circuit and input protective features.

1. High speed current limiting input fuses and line reactors.

2. Solid state instantaneous overcurrent trip.

3. Undervoltage protection with automatic restart.

4. Ground fault protection.

F. Provide the following internal protective features.

1. Transient surge protection.

2. Transistor overcurrent protection.

3. Current limit, inverse time type.

4. DC bus fuse protection and discharge circuit.

5. DC bus overvoltage trip.

G. Provide the following output protective features.

1. Inverse time motor overload protection.

2.04. DIAGNOSTIC AND FAULT CAPABILITY

A. The following conditions shall cause an orderly drive shutdown and lockout.

1. Incorrect phase sequence.

2. Blown input fuse or single phasing of supply.

3. Control power supply failure.

4. Instantaneous overcurrent.

5. Sustained overload.

6. Transistor overcurrent.

B. Provide complete built-in diagnostic and test capability to enable maintenance personnel to rapidly and accurately identify the cause of equipment failure.

2.05. SURFACE PREPARATION AND SHOP COATINGS

A. All non-current carrying metal parts of the equipment cabinet shall be cleaned of all weld spatter and other foreign material and given a heat cured, phosphatized chemical pre-treatment to inhibit rust.

B. Equipment shall be finish painted with one coat of manufacturers standard electrocoated, heat cured enamel.

C. Unpainted non-current carrying parts shall receive a protective zinc plating to prevent corrosion. Printed circuit boards shall be coated with a protective conformal epoxy. All device contacts shall be silver cadmium plated.

2.06. SHOP TESTING

A. Perform manufacturers' standard production testing and inspection.

2.07. DESIGN BASIS

A. VFD shall be Square D Altivar or Rockwell Allen-Bradley.

PART 3 EXECUTION

3.01. INSTALLATION

A. Install the equipment in accordance with the manufacturer's instructions.

B. Remove temporary lifting angles, lugs and shipping braces. Touch-up damaged paint finishes.

3.02. FIELD TESTING

A. Make the following minimum test and checks before the manufacturer's representative is called in for testing and adjustment.

1. Verify that all connections are completed in accordance with shop drawings.

2. Verify supply voltage and phase sequence are correct.

3. Check mechanical interlocks for proper operation.

4. Test ground connections for continuity and resistance.

5. Check control circuit interlocking and continuity.

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B. The manufacturer's service technician shall perform start-up and adjustment of the drive(s).

3.03. ADJUSTMENT

A. Make all VFD internal adjustments and all adjustments necessary for manual and automatic operation of the entire system of driven equipment.

3.04. CLEANING

A. Remove all rubbish and debris from inside and around the equipment. Remove dirt, dust, or concrete spatter from the interior and exterior of the equipment using brushes, vacuum cleaner, or clean, lint-free rags. Do not use compressed air.

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SECTION 16500

LIGHTING SYSTEM

PART 1 GENERAL

1.01. SCOPE OF WORK

A. Furnish all labor, materials, equipment and incidentals required and install a complete lighting system ready for operation as shown on the Drawings and as specified herein.

1.02. REFERENCE STANDARDS

A. All lighting fixtures shall be in accordance with the National Fire Protection Association (NFPA) NFPA 70 "National Electrical Code" (NEC) and shall be constructed in accordance with the latest edition of the Underwriters Laboratories (UL) "Standards for Safety, Electric Lighting Fixtures."

B. All lighting fixtures shall be UL labeled. Lighting equipment shall comply with UL standards pertaining to luminaires including: UL 1570 Fluorescent Lighting Fixtures; UL 1598 HID Lighting Fixtures; UL 1029 HID Ballasts; UL 542 Lampholders, Starters and Starter Holders for Fluorescent Lamps and UL 844 Standard for Electric Lighting Fixtures for Use in Hazardous (Classified) Locations

PART 2 PRODUCTS

2.01. MATERIALS

A. Luminaires (Lighting Fixtures)

1. Luminaire types shall be furnished as required by the "Lighting Fixture Schedule" on the Drawings. The catalog numbers are given as a guide to the design and quality of fixture desired.

B. Lamps

1. General Lamps

a. Fluorescent lamps shall be low mercury, tri-phosphors with a correlated color temperature (CCT) of 3500 Kelvin and a color rendering index (CRI) of not less than 80 CRI. Compact types are as shown on the "Lighting Fixture Schedule".

2. Fluorescent T8 Lamps

a. Rated lamp life shall be at least 15,000 and 20,000 hours operating on an instant start and programmed rapid start mode, respectively.

3. Fluorescent T5 and T5HO Lamps

a. Rated lamp life shall be at least 20,000 hour based on three-hour starts.

4. Fluorescent T8 U Tube Lamps

a. Rated lamp life shall be at least 15,000 and 20,000 hours operating on an instant start and programmed rapid start mode, respectively.

5. Fluorescent TT5 Lamps

a. Rated lamp life shall be at least 12,000 hour based on three-hour starts.

6. HID (Metal Halide and High Pressure Sodium) Lamps

a. Lamps shall be designed for operation with the specified ballast assembly

b. Lamp shall be designed for operation in the specified mounting position.

c. HPS Lamps shall have two arc tubes so that instant restrike will occur in the event of a momentary power failure.

d. Rated lamp life shall be a minimum or 24,000 hours for HPS lamps based on three-hour starts.

e. Rated lamp life shall be a minimum or 20,000 hours for MH lamps based on three-hour starts.

f. Lamps shall be clear or coated, as specified on the "Lighting Fixture Schedule" or as required for proper luminaire performance.

7. Incandescent lamps shall be inside frosted, halogen, 2,500 hour minimum life. Size and type shall be as shown on the "lighting fixture schedule."

8. Metal Halide lamps shall be ANSI Type O, open-rated protected lamps for use in open or enclosed luminaires. Lamps shall have exclusionary base for use in standard or protected type mogul sockets.

9. All lamps shall be of one manufacturer and shall be as manufactured by Osram Sylvania; General Electric; Philips or equal.

C. Ballasts

1. Program Rapid Start Fluorescent Ballasts

a. Provide energy efficient fluorescent ballasts conforming where relevant to:

1) UL 935, "Fluorescent-Lamp Ballasts,"

2) ANSI C82.1, "Ballasts for Fluorescent Lamps - Specification,"

3) ANSI C82.11, "High Frequency Fluorescent Lamp Ballasts,"

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4) ANSI C82.2 "Methods of Measurement of Fluorescent Lamp Ballasts,"

5) NFPA 70 and Public Law 109-58-2005, as applicable.

b. Shall be electronic (solid state) Program Rapid Start Ballast and have a Certified Ballast Manufacturer (CBM) label, unless noted otherwise.

c. All ballasts used in exterior applications or areas where ambient temperatures may fall below 50 degrees F shall have a minimum starting temperature of 0 degrees F unless otherwise specified.

d. All interior ballasts shall have a minimum starting temperature of 50 degrees F.

e. Ballasts shall be series wired type and designed to operate the number and length of lamps specified.

f. The total harmonic distortion (THD) of each ballast shall be in accordance with the requirements of the utility company and in no case shall it be greater than 10 percent THD.

g. Use Class "P" thermal protected ballasts.

h. Ballasts shall be of high power factor, with a power factor of 0.9 or greater.

i. Ballasts shall have a maximum lamp current crest factor of 1.7.

j. Light output (ballast factor) shall be between 0.85 and 1.0 when tested with a compatible full-wattage lamp (T-8 or T-5).

k. Ballast shall be regulated to maintain light output which does not vary more than plus/minus 5 percent for all rapid start fluorescent lamps in the proper lamp/ballast combination within operating ranges of plus/minus 10 percent of center voltage.

l. Cathode voltage for rapid start lamps during starting shall be between 3.4 and 4.5V across a dummy load and between 2.5 and 4.4V during operation.

m. Ballast shall have a frequency of operation of 40 kHz or greater and incorporate adequate 60 Hz filtering in order to operate with less than 5 percent flicker (maximum 0.20 Flicker Index) with any rare earth phosphor lamp suitable for the ballast.

n. Ballast shall provide normal rated life for the lamp specified.

o. All electronic ballasts shall be warranted for parts and replacement for 1 full year from the date of installation.

p. Ballasts shall have an "A" sound rating or better.

q. Ballast shall not contain polychlorinated biphenyls (PCBs) and shall be labeled "NO PCBS."

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r. Ballasts shall be designed to operate on the voltage system to which they are connected and designated by the ballast manufacturer as suitable and UL listed for operating the specified lamps

s. Ballasts shall meet the requirements of the Federal Communications Commission Rules and Regulations, Part 18, Subpart C (RF Lighting Devices), regarding radio frequency interference (RFI) and electromagnetic interference (EMI).

t. Electronic fluorescent ballasts shall be universal voltage type capable of operating from 110V to 302V rms input.

u. Electronic ballasts shall be as manufactured by Advance, similar by Osram Sylvania; Universal Lighting or equal.

2. HID (Metal Halide and High Pressure Sodium) Ballasts

a. Ballast assemblies shall be designed to operate at the specified voltage, and designated by the ballast manufacturer as suitable and UL listed for operating the specified lamps.

b. Lamp current crest factor shall not exceed 1.8.

c. Ballast assemblies shall be capable of starting and operating the specified lamps within a range of plus 10 percent of the specified voltage.

d. Total Line Current Harmonic Distortion shall not exceed 33 percent.

e. Electronic ballast assemblies shall meet the requirements of the Federal Communications Commission Rules and Regulations, Part 18, Subpart C (RF Lighting Devices), regarding radio frequency interference (RFI) and electromagnetic interference (EMI).

f. Ballast shall be of high power factor or power factor corrected type, with a power factor of 0.9 or greater.

g. Insulation shall be Class 180 degree C minimum.

h. Ballast assemblies shall start lamps at a minimum temperature of minus 20 degrees F.

i. In addition to the above stated HID Ballast requirements, High pressure sodium ballasts shall be of the constant wattage auto-transformer type of the correct size and voltage for the fixture it is to serve as shown on the "Lighting Fixture Schedule". All ballasts shall be as manufactured by Advance Transformer Co., similar by Holophane Lighting; Universal Manufacturing; Osram Sylvania or equal.

j. In addition to the above stated HID Ballast requirements, metal halide ballasts shall be Pulse Start of the constant wattage auto-transformer type of the correct size and voltage for the fixture it is to serve as shown on the "Lighting Fixture Schedule". All ballasts shall be as manufactured by Advance Transformer Co.; Holophane Lighting; Universal Manufacturing; Osram Sylvania or equal

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PART 3 EXECUTION

3.01. INSTALLATION

A. Each fixture shall be a completely finished unit with all components, mounting and/or hanging devices necessary, for the proper installation of the particular fixture in its designated location and shall be completely wired ready for connection to the branch circuit wires at the outlet.

B. All flush mounted fixtures shall be supported from the structure and shall not be dependent on the hung ceilings for their support.

C. Fixtures noted to be installed flush in suspended ceilings shall be of mounting types suited for the type ceiling involved. It shall be the responsibility of the electrical contractor to verify the ceiling types prior to ordering fixtures.

D. Flexible fixture hangers shall be used for all pendant mounted fixtures. Fixtures 2-ft long and larger shall be supported with a minimum of two fixture hangers.

E. Conduit run in areas with hung ceilings shall be installed in the space above the hung ceiling as close to the structure as possible. Conduits shall be supported from the structure.

F. Exterior lighting poles shall be mounted plumb.

G. Fixture locations are shown on the Drawings in approximate locations; however exact locations shall be coordinated so as to avoid conflicts with HVAC ducts, equipment and other obstacles.

H. Where the Drawings state a particular mounting height, it shall imply that the bottom of the fixture shall be mounted at the stated mounting height above the finished floor, unless specifically noted otherwise.

I. The minimum mounting height for the bottom of lights and exit signs shall be 80-in above the finished floor in compliance with Americans with Disabilities Act (ADA).

3.02. REPLACEMENT

A. Lamps (except for HID) used during the building construction, prior to 2 weeks from completion of the work, shall be removed and replaced with new lamps.

B. Metal halide lamps that produce a green, blue, or pink color shift after 100 hours of operation shall be replaced at no additional cost to the Owner.

3.03. CLEANING UP

A. Plastic dust cover bags to be provided with new parabolic reflector lighting fixtures shall be removed after all construction activity that may cause dust formation on reflector surfaces has been completed.

B. All fixtures shall be left in a clean condition, free of dirt and defects, before acceptance by the Engineer.

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# SECTION 16600

# UNDERGROUND SYSTEM

## PART 1 GENERAL

### 1.01. SCOPE OF WORK

A. Furnish and install a complete underground system of raceways, manholes and handholes as shown on the Drawings and as specified herein.

B. All underground systems shall be encased as shown on the drawings.

C. The Contractor shall be responsible for setting manholes and handholes at the proper elevation such that the pitch of raceways will be towards manholes and handholes and away from structures, vaults and buildings.

D. Where referred in this Section, raceways are underground conduits – Ductbanks are a collection of underground raceways. Underground system is the collection of underground raceways, manholes and handholes.

E. Ductbanks shall be constructed as shown on the drawings up to the building, structure, vault, manhole and handhole.

1. Ductbank, manhole and handhole depths vary. Coordinate with other utilities, yard piping, yard structures and field conditions to determine required depths and install raceways, manholes and handholes at that required depth at no additional cost to the Owner.

2. Ductbank routing and manhole/handhole locations shown on the Drawings are diagrammatically depicted. Coordinate with other utilities, yard piping, yard structures and field conditions to determine required paths and depths at no additional cost to the Owner.

## PART 2 PRODUCTS

### 2.01. MATERIALS

A. Raceways shall be polyvinyl chloride conduit.

B. Cable racks, supports, pulling-in irons, manhole steps and hardware shall be galvanized steel as manufactured by Line Materials Co.; Underground Devices, Inc.; Chance or equal.

C. Precast manholes and handholes shall be designed as specified below for precast concrete structures.

1. Provide lifting lugs in each precast section for handling.

2. All sections, flat slab tops and grade rings shall conform to ASTM C478.

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3. Base, riser and transition top sections shall have tongue and groove joints.

4. Compressive strength for shipping shall be 4000 psi.

5. Design precast concrete base, riser, transition top, flat slab top and grade ring for a minimum H-20 loading plus earth load. Earth load shall be calculated from the future grade indicated as final grade with a unit weight of 130 pcf.

6. The date of manufacture, name and trademark of manufacturer shall be marked on the inside of each precast section.

7. Provide integrally cast knock-out panels in precast concrete manhole and handhole sections at locations indicated and with sizes indicated. Knock-out panels shall have no steel reinforcing.

8. Seal tongue and groove joints of precast manhole and handhole sections with rubber O-ring gasket. O-ring gasket shall conform to ASTM C443. In lieu of the O-ring gasket, a flexible joint sealant may be used. Sealant shall be Kent Seal No. 2; Con Seal No. 2; Ram-Nek or equal. Completed joints shall withstand 15 psi internal water pressure without leakage or displacement of gasket or sealant.

9. Dampproofing shall be Hydrocide 648 by Sonneborn Building Products; Dehydratine 4 by A.C. Horn, Inc.; RIW Marine Liquid by Toch Bothers, or equal.

D. Handholes shall be precast concrete, heavy-duty type, designed for a Class H-20 wheel load and conform to ASTM C478. Precast units shall be as manufactured by Chase Precast Corp.; Rotondo; American Precast Co. or equal and constructed to dimensions as shown on the Drawings.

E. Manhole and handhole frames and covers shall be cast iron, heavy duty type for Class H-20 wheel loading as manufactured by Neenah; LeBaron; Vulcan or equal. Covers shall be marked and sized as shown on the Drawings.

F. Ground rods and other grounding materials and methods shall be as specified.

G. Bell ends and plastic duct spacers shall be as manufactured by Carlon; Underground Devices Inc. or equal.

H. Pull line for spare conduits shall be 1/8-in nylon rope.

I. Detectable Warning Tape

1. Each duckbank section shall be marked by means of a detectable warning tape (tracer tape) as shown on the Drawings. The detectable warning tape shall be capable of being detected or located by either conductive or inductive location techniques.

2. The detectable warning tape shall consist of 5 mil (.005-in) overall thickness; five-ply composition; ultra-high molecular weight; virgin polyethylene; acid; alkaline and corrosion resistant; with 150 pounds of tensile break strength minimum per 6-in width.

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3. The top side of the tracer tape shall be color banded red for electrical and high voltage lines, and orange for signal, communication, telephone and fire alarm lines. Tracer tape shall be 4-in wide with four color bands. The tape shall be inscribed with the warning message for the utility such as "CAUTION – ELECTRICAL LINED BURIED BELOW". Tape shall be as manufactured by Mutual Industries, Inc.; Terra Tape, Div. of Reef Industries Inc. or equal.

PART 3 EXECUTION

3.01. INSTALLATION

A. Install raceways to drain away from buildings. Raceways between manholes or handholes shall drain toward the manholes or handholes. Raceway slopes shall not be less than 3-in per 100-ft.

B. Use plastic spacers located not more than 4-ft apart to hold raceways in place. Spacers shall provide not less than 2-in clearance between raceways and edge of envelope.

C. The minimum cover for raceway banks shall be 24-in unless otherwise permitted by the Engineer.

D. Raceway terminations at manholes shall be with end bells for PVC conduit and insulated throat grounding bushings for steel conduit.

E. Where bends in raceways are required, use long radius elbows, sweeps and offsets.

F. Swab all raceways clean before installing cable.

G. Plug and seal spare raceways watertight at all manholes, buildings and structures.

H. Seal the ends of raceways and make watertight at all manholes, buildings and structures.

I. Install pulling-in irons opposite all raceway entrances to manholes.

J. Train cables in manholes and handholes and support and restrain them on racks and hooks. Furnish inserts on all manhole and handhole walls for mounting future racks as well as racks required for present installation.

K. PVC Coated Rigid galvanized steel conduit shall be used for elbows and risers at the utility pole for electrical and telephone service conduits.

L. PVC coated rigid galvanized steel elbows shall be used for pad-mounted transformer stub-ups and all stub-ups through concrete floors, walls and slabs.

M. A pull line shall be installed and left in all spare raceways.

N. Install detectable warning tape in all ductbanks as shown on the Drawings. Where trench exceeds 24-in width, provide additional detectable tape runs to mark each side of the ductbank in addition to the one in the center.

O. Manhole and Handhole Installation

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1. Place bases on bed of 12-in screened gravel. Set base grade so that a minimum grade adjustment of 4-in of brickwork is required to bring the manhole and handhole frame and cover to final grade.

   a. Use precast concrete grade rings or brick and non-shrink mortar to adjust frame and cover to final grade.

2. Set precast sections plumb with a 1/4-in maximum out-of-plumb tolerance. Seal joints of precast sections with either a rubber O-ring set in a recess or a flexible joint sealant used in sufficient quantity to fill 75 percent of the joint cavity. Fill the outside and inside joint with non-shrink grout and finished flush with the adjoining surfaces. Caulk the inside of leaking barrel section joints with lead wool or non-shrink grout. If leaks appear in the manholes or handholes the inside joints shall be cleaned out and remade in a manner that will result in a watertight joint.

3. Allow joints to set for 24 hours before backfilling. Backfilling shall be performed by bringing the fill up evenly on all sides.

4. Plug holes in concrete with non-shrink grout or non-shrink grout in combination with concrete plugs. Finish flush on the inside.

5. Cut holes in precast sections to accommodate conduits prior to setting manhole and handhole sections in place.

3.02. CLEANING

A. All new manholes and handholes shall be thoroughly cleaned of all silt, debris and foreign matter prior to final inspection.

END OF SECTION

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# SECTION 16660

# GROUNDING SYSTEM

## PART 1 GENERAL

### 1.01. SCOPE OF WORK

A. Furnish all labor, materials, equipment and incidentals required and install a complete grounding system in strict accordance with Article 250 of the National Electrical Code NEC.

B. All raceways, conduits, ducts and multi-conductor cables shall contain equipment grounding conductors sized in accordance with the NEC. Minimum sizes shall be No. 12 AWG.

1.02. A supplemental grounding conductor shall be provided from each switchgear, switchboard, motor control center, power panelboard, lighting panelboard, to the buried ground grid. Supplemental grounding conductors shall be installed in PVC Schedule 80 conduit.

## PART 2 PRODUCTS

### 2.01. MATERIALS

A. Conduit shall be as specified under Section 16110.

B. Wire shall be as specified under Section 16120.

C. Ground rods shall be 3/4-in by 10-ft copper clad steel and constructed in accordance with UL 467. The minimum copper thickness shall be 0.25 mm. Ground rods shall be Copperweld; Blackburn; Erico, Inc. or equal.

D. Grounding conduit hubs shall be malleable iron type, and of the correct size for the conduit, as manufactured by Thomas & Betts Co.; Catalog No. 3940 Series, similar by Burndy; O.Z. Gedney Co. or equal.

E. Water pipe ground clamps shall be cast bronze saddle type, and of the correct size for the pipe, as manufactured by Thomas & Betts Co. Cat. No. 2 (1/2-in, 3/4-in, or 1-in size), similar by Burndy; O.Z. Gedney Co. or equal and of the correct size for the pipe.

F. Buried grounding connections shall be by Cadweld process, or equal exothermic welding system.

1. Molds, cartridge materials and accessories shall be provided in kit form and selected per the manufacturer's written instructions for specific types, sizes and combinations of conductors and connected items. Molds and powder shall be furnished by the same manufacturer.

## PART 3 EXECUTION

### 3.01. INSTALLATION

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A. Run grounding electrode conductors in rigid steel conduits. Bond the protecting conduits to the grounding electrode conductors at both ends. Do not allow water pipe connections to be painted. If the connections are painted, dis-assemble them and re-make them with new fittings.

B. Install equipment grounding conductors with all feeders and branch circuits.

C. Bond all steel building columns in new structures together with ground wire in rigid conduit and connect to the distribution equipment ground bus, as shown on the Drawings.

D. Ground wire connections to structural steel columns shall be made with exothermic welds.

E. Metal conduits stubbed into a motor control center or floor mounted electrical enclosure shall be terminated with insulated grounding bushings and connected to the motor control center or electrical enclosure ground bus. Bond boxes mounted below motor control centers to the motor control center ground bus. Size the grounding wire in accordance with NEC Table 250-122, except that a minimum No. 12 AWG shall be used.

F. Liquid tight flexible metal conduit in sizes 1-1/2-in and larger shall have bonding jumpers. Bonding jumpers shall be external, run parallel (not spiraled) and fastened with plastic tie wraps.

G. Ground transformer neutrals to the nearest available grounding electrode with a conductor sized in accordance with NEC Article 250-66.

H. Drive grounding electrodes as shown on the Drawings.

I. All equipment enclosures, motor and transformer frames, conduits systems, cable armor, exposed structural steel and all other equipment and materials required by the NEC to be grounded, shall be grounded and bonded in accordance with the NEC.

J. Seal exposed connections between different metals with No-Oxide Paint Grade A or equal.

K. Ground metal poles supporting outdoor lighting fixtures to a supplemental grounding electrode (rod) in addition to the separate equipment grounding conductor run with the supply branch circuit.

L. Ufer Ground (Concrete-Encased Grounding Electrode): Fabricate in accordance with NEC Paragraph 250.52 using a minimum of 20-ft of bare copper conductor not smaller than No. 4 AWG. Where base of foundation is less than 20-ft in length, coil excess conductor within base of concrete foundation. Extend grounding conductor below grade and connect to building grounding grid, ground loop, or grounding electrode external to concrete.

M. Install driven ground rods in manholes and handholes close to wall and set rod depth so 4-in will extend above finished floor. Protect ground rods with double wrapping of pressure-sensitive tape or heat shrunk insulating sleeve from 2-in above to 6-in below concrete floor. Seal floor opening with waterproof, non-shrink grout. Where ground rods are installed outside of manhole or handhole, provide a No. 4/0 AWG bare, tinned copper conductor from ground rod into manhole or handhole through a waterproof sleeve in the wall.

3.02. INSPECTION AND TESTING

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A. Inspect the grounding and bonding system conductors and connections for tightness and proper installation.

B. Use Biddle Direct Reading Earth Resistance Tester or equivalent test instrument to measure resistance to ground of the system. Perform testing in accordance with test instrument manufacturer's recommendations using the fall-of-potential method.

C. Resistance to ground testing shall be performed during dry season. Submit test results in the form of a graph showing the number of points measured (12 minimum) and the numerical resistance to ground.

D. Testing shall be performed before energizing the distribution system.

E. Test all grounded cases and metal parts associated with the electrical equipment for continuity with the ground system.

F. Notify the Engineer immediately if the resistance to ground for any building or system is greater than five ohms.

END OF SECTION

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