CITY CLERK
ORIGINAL

CONTRACT SET

PROJECT SPECIFICATIONS AND CONTRACT DOCUMENTS

C-7705
06/14/2011

PROJECT 067013

**ARROWHEAD WATER RECLAMATION FACILITY
MISCELLANEOUS IMPROVEMENTS - SUPPLEMENTAL
CLORINATION/DECHLORINATION DISINFECTION SYSTEM**

APRIL 2011

GLENDALE

DATED 3/15/2011

CITY OF GLENDALE

ENGINEERING DEPARTMENT
5850 W. Glendale Avenue, Glendale, Arizona 85301 (623) 930-3630

GLENDALE

Engineering Department

Memorandum

DATE: April 28, 2011
TO: All Plan and Specification Holders
FROM: Engineering
SUBJECT: PROJECT NO. 067013 – ARROWHEAD WATER RECLAMATION FACILITY MISCELLANEOUS IMPROVEMENTS – SUPPLEMENTAL CHLORINATION\DECHLORINATION DISINFECTION SYSTEM

ADDENDUM NO. 1

In accordance with the contract documents "Information for Bidders," Page 4, Paragraph 12 CHANGES TO PLANS AND DOCUMENTS, the following revisions to the plans and specifications shall become a part of the contract documents and the bidder shall acknowledge receipt thereof as directed in Paragraph 13 of the Information for Bidders.

1. Drawing C-02, Detail 1, The following dimensions will be added to the drawing:
The UV system channel width is approx 6'-0". The UV system channel depth is approx. 10'-9" from top of concrete. The filter system influent and effluent channel widths are approx 4'-0". The filter influent channel depth is approx. 9'-0" from top of concrete. The filter effluent channel depth is approx 8'-0" from top of concrete.

2. Specification 15052, Piping Schedule - Sodium Bisulfite, delete comment "Aboveground to be insulated and heat traced".

Registered Professional Engineer (Civil)
CERTIFICATE NO.
42397
BRIAN J.
BERNARD
Date Signed
ARIZONA, U. S. A.

EXPIRES 03-31-2014

GLENDALE AZ

Engineering Department

Memorandum

DATE: April 29, 2011
TO: All Plan and Specification Holders
FROM: Engineering
SUBJECT: PROJECT NO. 067013 – ARROWHEAD WATER RECLAMATION FACILITY MISCELLANEOUS IMPROVEMENTS – SUPPLEMENTAL CHLORINATION\DECHLORINATION DISINFECTION SYSTEM

ADDENDUM NO. 2

In accordance with the contract documents "Information for Bidders," Page 4, Paragraph 12 CHANGES TO PLANS AND DOCUMENTS, the following revisions to the plans and specifications shall become a part of the contract documents and the bidder shall acknowledge receipt thereof as directed in Paragraph 13 of the Information for Bidders.

Question from Bidders: What is the manufacturer, model and fault current rating of the 2 Pole 40 Amp Breaker to be installed in the existing Distribution Panel #2?
Response: Cutler Hammer Pow-R-Line, Fault Current Rating = 65KAIC

Question from Bidders: For Conduits SHS-1, 2, 11, 12, 23 and 32 the conduit schedule states, "NEW UNDERGROUND CONDUIT, EXISTING DUCTBANK SYSTEM". This statement says the conduit is new and then says it is existing? These ductbanks are not shown. What is the routing to determine cable length to go into existing? Where do existing conduits start and stop? What manholes or handholes do these conduits go to or not go to?
Response: Requested information is shown on Drawings E-04, E-05 and E-07.

Question from Bidders: Provide I/O List in accordance with specification section 17903
Response: See attached I/O List.

EXPIRES 03-31-2014

Glendale ARWRF Miscellaneous Improvements - Supplemental Chlorination/Dechlorination Disinfection System I/O LIST

P&ID	PLC	I/O TYPE	RACK	SLOT	POINT	I/O ADDRESS	SIGNAL TAG	DESCRIPTION
N-02	SHC-PLC-100	DI					XL-103	Sodium Hypochlorite Pump No. 3 Run Status
N-02	SHC-PLC-100	DI					YA-103A	Sodium Hypochlorite Pump No. 3 Fail Alarm
N-02	SHC-PLC-100	DI					YL-103	Sodium Hypochlorite Pump No. 3 Auto Mode
N-02	SHC-PLC-100	DI					YA-103B	Sodium Hypochlorite Pump No. 3 High Press Alarm
N-02	SHC-PLC-100	DI					YA-103C	Sodium Hypochlorite Pump No. 3 Diaphragm Leak
N-02	SHC-PLC-100	DI					XL-102	Sodium Hypochlorite Pump No. 2 Run Status
N-02	SHC-PLC-100	DI					YA-102A	Sodium Hypochlorite Pump No. 2 Fail Alarm
N-02	SHC-PLC-100	DI					YL-102	Sodium Hypochlorite Pump No. 2 Auto Mode
N-02	SHC-PLC-100	DI					YA-102B	Sodium Hypochlorite Pump No. 2 High Press Alarm
N-02	SHC-PLC-100	DI					YA-102C	Sodium Hypochlorite Pump No. 2 Diaphragm Leak
N-03	SHC-PLC-100	DI					LAH-101	Sodium Bisulfite Storage Tank High Level Alarm
N-03	SHC-PLC-100	DI					LAL-101	Sodium Bisulfite Storage Tank Low Level Alarm
N-03	SHC-PLC-100	DI					XL-101	Sodium Bisulfite Pump No. 1 Run Status
N-03	SHC-PLC-100	DI					YA-101A	Sodium Bisulfite Pump No. 1 Fail Alarm
N-03	SHC-PLC-100	DI					YL-101	Sodium Bisulfite Pump No. 1 Auto Mode
N-03	SHC-PLC-100	DI					YA-101B	Sodium Bisulfite Pump No. 1 High Press Alarm
N-03	SHC-PLC-100	DI					YA-101C	Sodium Bisulfite Pump No. 1 Diaphragm Leak
N-03	SHC-PLC-100	DI					XL-102	Sodium Bisulfite Pump No. 2 Run Status
N-03	SHC-PLC-100	DI					YA-102A	Sodium Bisulfite Pump No. 2 Fail Alarm
N-03	SHC-PLC-100	DI					YL-102	Sodium Bisulfite Pump No. 2 Auto Mode
N-03	SHC-PLC-100	DI					YA-102B	Sodium Bisulfite Pump No. 2 High Press Alarm
N-03	SHC-PLC-100	DI					YA-102C	Sodium Bisulfite Pump No. 2 Diaphragm Leak
N-02	SHC-PLC-100	DO					HS-103	Sodium Hypochlorite Pump No. 3 Pump Run
N-02	SHC-PLC-100	DO					HS-102	Sodium Hypochlorite Pump No. 2 Pump Run
N-03	SHC-PLC-100	DO					HS-101	Sodium Bisulfite Pump No. 1 Pump Run
N-03	SHC-PLC-100	DO					HS-102	Sodium Bisulfite Pump No. 2 Pump Run
N-02	SHC-PLC-100	AI					SI-103	Sodium Hypochlorite Pump No. 3 Speed Indication
N-02	SHC-PLC-100	AI					SI-102	Sodium Hypochlorite Pump No. 2 Speed Indication
N-03	SHC-PLC-100	AI					SI-101	Sodium Bisulfite Pump No. 1 Speed Indication
N-03	SHC-PLC-100	AI					SI-102	Sodium Bisulfite Pump No. 2 Speed Indication
N-04	PLC-4	AI					AI-101	UV Effluent Chlorine Residual Analyzer
N-04	SHC-PLC-100	AI					AI-101	Final Effluent Chlorine Residual Analyzer
N-02	SHC-PLC-100	AO					SC-103	Sodium Hypochlorite Pump No. 3 Speed Control
N-02	SHC-PLC-100	AO					SC-102	Sodium Hypochlorite Pump No. 2 Speed Control
N-03	SHC-PLC-100	AO					SC-101	Sodium Bisulfite Pump No. 1 Speed Control
N-03	SHC-PLC-100	AO					SC-102	Sodium Bisulfite Pump No. 2 Speed Control

PROJECT SPECIFICATIONS AND CONTRACT DOCUMENTS

MAYOR
Elaine M. Scruggs

VICE-MAYOR
Steven E. Frate

COUNCIL MEMBERS
Norma S. Alvarez
Joyce V. Clark
Yvonne J. Knaack
H. Philip Lieberman
Manuel D. Martinez

CITY MANAGER
Ed Beasley

CITY CLERK
Pamela Hanna

CITY ATTORNEY
Craig D. Tindall

CITY ENGINEER
Larry J. Broyles

GLENDALE AZ

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NOTICE TO CONTRACTORS

Sealed bids shall be either mailed to the City of Glendale Engineering Department, 5850 West Glendale Avenue, Glendale, Arizona, 85301, or hand-delivered to the Engineering Department office, third floor, 5850 West Glendale Avenue, Glendale, Arizona, for furnishing all plant, material, equipment and labor, and to complete construction of: **PROJECT NO. 067013 ARROWHEAD WATER RECLAMATION FACILITY MISCELLANEOUS IMPROVEMENTS - SUPPLEMENTAL CLORINATION/DECHLORINATION DISINFECTION SYSTEM.** This project entails the installation of a fully functional new supplemental Chlorination and Dechlorination system with all accessories including instrumentation and controls at the Arrowhead Water Reclamation Facility.

Bids must be received by the Engineering Department of the City of Glendale no later than 2:00 P.M., MAY 2, 2011. Any bid received after that time will not be considered and will be returned to the bidder. At that time, the bids will be publicly opened and read aloud in the Engineering Department Conference Room, 5850 West Glendale Avenue, Glendale, Arizona.

A pre-bid conference will be held on APRIL 26, 2011, at 2:00 P.M., in the Engineering Department Conference Room, 5850 West Glendale Avenue, Glendale, Arizona. Bidders, contractors, and other interested parties are invited to attend this conference which will be conducted by the Owner and Engineer to answer any questions

Plans, specifications and contract documents may be examined, and copies may be obtained at City of Glendale Engineering Department, 5850 West Glendale Avenue, Glendale, Arizona. A non-refundable charge of $40.00 shall be paid for each set of plans and specifications issued from this office.

Each bid shall be in accordance with the plans, specifications and contract documents, and shall be set forth and submitted on the BID DOCUMENTS included with the project specifications book. The BID DOCUMENTS may be removed from the project specifications book and submitted independently of such book. Each bid shall be accompanied by a proposal guarantee, in the form of a certified or cashier's check or bid bond for ten percent (10%) of the amount of bid, made payable to the order of the City of Glendale, Arizona, to insure that the successful bidder will enter into the contract if awarded to him and submit the required Certificate of Insurance, Payment Bond and Performance Bond. All proposal guarantees, except those of the three lowest qualified bidders, will be returned immediately following the opening and checking of proposals. The proposal guarantees of the three lowest qualified bidders will be returned immediately after the contract documents have been executed by the successful bidder. The proposal guarantee shall be declared forfeited as liquidated damages if the successful bidder refuses to enter into said contract or submit the Certificate of Insurance, Payment Bond and Performance Bond after being requested to do so by the City of Glendale, Arizona.

The City of Glendale reserves the right to reject any or all bids or waive any informality or irregularity in a bid. No bidder may withdraw his bid for a period of fifty (50) days after opening and reading of the bids.

The City of Glendale is an equal opportunity employer and minority business enterprises and women's business enterprises are encouraged to submit bids.

CITY OF GLENDALE, ARIZONA

Published: APRIL 14 AND 21, 2011
The Glendale Star

INFORMATION FOR BIDDERS

1. ELIGIBILITY OF CONTRACTORS: When calling for bids for contracts for public work to be performed on behalf of the State or any political subdivision thereof, which will be paid for from public funds, no bid shall be considered for performance of a contract, including construction work which is not submitted by a bidder duly licensed as a contractor in this State. No bid shall be awarded to any contractor or entity not authorized to do business in the State of Arizona by the Arizona Corporation Commission, as required by statute.

2. PROPOSAL: Bids to receive consideration shall be made in accordance with the following instructions:

(a) Before submitting a bid, bidders shall carefully examine the plans and specifications and contract documents, visit the site of the work, fully inform themselves as to all existing conditions and limitations.

(b) Bids shall be submitted on the "PROPOSAL" forms provided and delivered to the City of Glendale Engineering Department on or before the day and hour set in the "NOTICE TO CONTRACTORS," as published. Bids shall be enclosed in a sealed envelope marked on the outside lower right-hand corner indicating:

1. The bidder's name and address.
2. The project number.
3. The title of the project.
4. The time and date the bids are to be received.

(c) It is the sole responsibility of the bidder to see that his bid is received in proper time. Any bids received after the scheduled closing time for receipt of bids will be returned to the bidder unopened.

(d) The signatures of all persons shall be in longhand. Any interlineations, alterations, or erasures must be initialed by the signer of the bid.

(e) Bids shall not contain any recapitulations of the work to be done. No oral, telegraphic, telephonic, or modified proposals will be considered.

3. BID SECURITY: Each proposal shall be accompanied by a proposal guarantee in the form of a certified or cashier's check or bid bond, with a properly executed Power of Attorney attached, in an amount equal at least to ten percent (10%) of the proposal payable without condition to the City. If a bid bond is submitted with the bid it shall be issued by a company licensed with the Arizona Department of Insurance and authorized to issue such bonds in this state. **NO BONDS ISSUED BY INDIVIDUAL SURETIES WILL BE ACCEPTED. The company issuing the bid bond shall have a rating of not less than A- in the BEST rating available at the time this project was let to bid**. The proposal guarantee shall guarantee that the bidder, if awarded the contract, will, within ten (10) working days after the award, execute such contract in accordance with the proposal and in manner and form required by the contract documents, and will furnish good and sufficient bond for the faithful performance of the same, a payment bond and a certificate of insurance. The bid securities of the three (3) lowest bidders will be retained until the contract is awarded, or other disposition made thereof. The bid securities of all bidders, except the three (3) lowest, will be returned promptly after the canvass of bids. In the event the Contractor fails, within ten (10)

working days after the award, to execute said Contract and deliver the Performance and Labor and Material Payment Bonds and the Certificate of Insurance, the Bid Security shall become the property of the City.

4. WITHDRAWAL OF BID: Any bidder may withdraw his bid, either personally, by telegram or by written request, at any time prior to the scheduled closing time for receipt of bids. No bid may be withdrawn by telephone. Any bid withdrawn will not be opened and will be returned to the bidder. After opening and reading of the bids, no bidder may withdraw his bid for a period of fifty (50) days from the date of opening and reading.

5. LATE BIDS: Bids received after the scheduled closing time for receipt of bids, as contained in the "Notice to Contractors," will not be considered and will be returned to the bidder.

6. AWARD OR REJECTION OF BIDS: The contract will be awarded to the lowest and best qualified responsive bidder complying with these instructions and with the "NOTICE TO CONTRACTORS." The City of Glendale, Arizona, however, reserves the right to accept or reject any or all bids or to waive any or all informalities or irregularities in the bid. Alternates may be accepted depending upon the availability of City funds. Accepted alternates will be considered in determining the lowest responsive and responsible bidder.

7. BIDDERS INTERESTED IN MORE THAN ONE BID: No person, firm or corporation shall be allowed to make, file, or be interested in more than one (1) bid for the same work unless alternate bids are called for in the specifications or any addenda. A person, firm, or corporation who has submitted a sub-proposal to a bidder, or who has quoted prices on materials to a bidder is not thereby disqualified from submitting a sub-proposal or quoting prices to other bidders.

8. CONTRACT AND BONDS: The form of contract, which the successful bidder as Contractor will be required to execute and the forms of bonds which he shall be required to furnish are included in the contract documents and should be carefully examined by the bidder. The successful bidder shall use the forms provided or such other forms as are acceptable by the City. The Contract and Performance and Labor and Material Payment Bonds will be executed in THREE (3) original counterparts. All bonds shall be issued by companies licensed with the Arizona Department of Insurance and authorized to issue such bonds in this state. **NO BONDS ISSUED BY INDIVIDUAL SURETIES WILL BE ACCEPTED. The company issuing any bond shall have a rating of not less than A- in the BEST rating available at the time this project was let to bid.**

9. INSURANCE REQUIREMENTS: Contractor, and each Sub-contractor performing work or providing materials related to this Agreement must procure and maintain the insurance coverages described (collectively, "Contractor's Policies"), until each Parties' obligations under this Agreement are completed. Contractor must at all times relevant hereto carry a commercial general liability policy with a combined single limit of at least $1,000,000 per occurrence and $2,000,000 annual aggregate. **Contracts in excess of $250,000 shall require $2,000,000 single occurrence/$5,000,000 annual aggregate.**

Sub-contractors must at all times relevant hereto carry a general commercial liability policy with a combined single limit of at least $1,000,000 per occurrence.

This commercial general liability insurance must include independent contractors' liability, contractual liability, broad form property coverage, products and completed operations, XCU

hazards if requested by the City, and a separation of insurance provision.

These limits may be met through a combination of primary and excess liability coverage.

Auto. A business auto policy providing a liability limit of at least $1,000,000 per accident for Contractor and $1,000,000 per accident for Sub-contractors and covering owned, non-owned and hired automobiles.

Workers' Compensation and Employer's Liability. A workers' compensation and employer's liability policy providing at least the minimum benefits required by Arizona law.

Equipment Insurance. Contractor must secure, pay for, and maintain all-risk insurance as necessary to protect the City against loss of owned, non-owned, rented or leased capital equipment and tools, equipment and scaffolding, staging, towers and forms owned or rented by Contractor or its Sub-contractors.

10. SUBCONTRACTORS LISTING AND CERTIFICATION OF CONTRACT COMPLIANCE: The contractor will be required to furnish the form of subcontractors listing and certification of contract compliance with the executed contract documents. This information is requested for tracking and insurance purposes only.

11. INTERPRETATION OF PLANS AND DOCUMENTS: If any person contemplating a bid for proposed contract is in doubt as to the true meaning of any part of the plans, specifications, or other proposed contract documents, or finds discrepancies in or omissions from the plans and specifications, he may submit to the Engineering Department, a written request for an interpretation or correction thereof. The person submitting the request will be responsible for its prompt delivery. Questions received less than ninety-six (96) hours before the bid opening time may not be answered. Any interpretation or correction of the documents will be made only by Addendum, duly issued and a copy of such Addendum will be mailed or delivered to each person receiving a set of such documents. The City of Glendale will not be responsible for any other explanations or interpretations of the proposed documents.

12. CHANGES TO PLANS AND DOCUMENTS: Any changes to the plans and documents shall be made only by Addendum. No verbal or other changes to the plans and documents will be valid. A copy of each Addendum will be mailed or delivered as provided in Section 12 below.

13. ADDENDUM: Any addenda will be faxed, mailed or delivered to all who are known by the City to have received a complete set of bid documents, and to offices where bid documents have been filed for review purposes. It is the responsibility of each bidder to ascertain that he has received all addenda issued by telephoning the office identified in the NOTICE TO CONTRACTORS as the location where bid documents are available prior to submitting his bid.

Bidders shall acknowledge all addenda in the appropriate location on the "PROPOSAL" form. Failure to acknowledge receipt of Addenda shall render the bid proposal non-responsive and it will be rejected.

14. ASSIGNMENT OF CONTRACT: No assignment by the Contractor of any contract to be entered into hereunder, or any part thereof, or of funds to be received thereunder by the Contractor, will be recognized by the Owner by the Owner unless such assignment has had prior approval of the Owner, and the Surety has been given due notice of such assignment in writing and has consented

thereto in writing.

15. PLANS AND SPECIFICATIONS TO SUCCESSFUL BIDDER: The successful bidder may obtain five (5) sets of plans and specifications for this project from the City.

16. TIME OF COMPLETION: The Contractor shall commence work under this project on or before the tenth day following receipt of the Notice to Proceed for that project from the City of Glendale and shall fully complete all work under the project within ONE HUNDRED AND FIFTY (150) consecutive calendar days from and including the date of receipt of such Notice to Proceed. Time is of the essence in the completion of all work required under this contract. The Contractor shall, at all times, during the continuance of the contract, prosecute the work with such force and equipment as is sufficient to complete all work within the time specified.

17. CITY OF GLENDALE TRANSACTION PRIVILEGE TAX: The City of Glendale transaction privilege tax shall **NOT** be waived under the provisions of this contract. The current privilege tax rate can be obtained from the City of Glendale Sales Tax and Licenses Department. The Contractor shall be responsible for reporting and payment of all city, county, state or federal taxes.

18. PRE-BID CONFERENCE: A pre-bid conference will be held on APRIL 26, 2011, at 2:00 P.M., in the Engineering Department Conference Room, 5850 West Glendale Avenue, Glendale, Arizona. Bidders, contractors, and other interested parties are invited to attend this conference which will be conducted by the Owner and Engineer to answer any questions.

19. ALTERNATES: Alternate proposals will not be considered unless called for in the documents or any addenda thereto. When alternates are requested, all requested alternates or alternate bid items, unless otherwise stated, shall be bid. If no change in the base bid will occur with the alternate, enter "No Change."

20. APPROVAL OF SUBSTITUTIONS: The materials, products and equipment described in the Documents and Addenda establish a standard or required function, dimension, appearance and quality to be met by any proposed substitution. No substitute will be considered, before bid opening, unless written request for approval has been received by the City Engineer at least ten (10) working days prior to the scheduled closing time for receipt of bids. Each such request shall include the name of the material or equipment for which it is to be substituted and a complete description of the proposed substitute including any drawings, cuts, performance and test data and any other information necessary for evaluation of the substitute. Bidder shall not be entitled to approval of a substitute.

If a substitute is approved, the approval shall be set forth in an Addendum. Bidders shall not rely upon approvals made in any other manner.

21. USE OF "EQUALS": When the specifications for materials, articles, products and equipment state "or equal," contractor may bid upon, and use materials, articles, products and equipment which will perform equally the duties imposed by the general design. The City Engineering Department will have the final approval of all materials, articles, products and equipment proposed to be used as an "equal." It shall not be purchased or installed without the prior written approval from the City Engineering Department.

Approvals for "equals," before bid opening, may be requested in writing to the City Engineering

Department for approval. Requests must be received at least ten (10) days prior to the date set for opening the Bid Proposals. The request shall state the name of the material, article, product or equipment for which the item is sought to be considered an equal and a complete description of the proposed equal including any drawings, cuts, performance and test data and any other information necessary for approval of the equal. All approvals will be issued in the form of an addendum.

22. EXAMINATION OF CONTRACT DOCUMENTS AND VISIT SITE: Before submitting a Bid Proposal, bidders should carefully examine the Contract Documents, visit the site of the work, fully inform themselves as to all existing conditions and limitations. No consideration will be granted for any alleged misunderstanding of the material, articles or piece of equipment to be furnished or work to be done. It is understood that the tender of the Bid Proposal carries with it the agreement to all items and conditions referred to herein or indicated in the Contract Documents.

23. BIDDERS IN DEFAULT: No bid will be awarded to any person, firm or corporation that is not authorized by the Arizona Corporation Commission to do business in the State of Arizona, in arrears or is in default to the City of Glendale upon any debt or contract, or that is a defaulter as surety or otherwise upon any obligation to the City of Glendale, or has failed to faithfully perform any previous contract with the City of Glendale.

END OF INFORMATION FOR BIDDERS

PROPOSAL

Place MESA, AZ

Date MAY 2, 2011

Proposal of FELIX CONSTRUCTION, a Corporation organized and existing under the laws of the State of Arizona. a partnership consisting of _____; or an individual trading as _____.

TO THE HONORABLE MAYOR AND COUNCIL
CITY OF GLENDALE
GLENDALE, ARIZONA

Gentlemen:

The undersigned hereby proposes and agrees to furnish any and all required labor, materials, construction equipment, transportation and services for the construction of: **PROJECT 067013 - ARROWHEAD WATER RECLAMATION FACILITY MISCELLANEOUS IMPROVEMENTS - SUPPLEMENTAL CLORINATION/DECHLORINATION DISINFECTION SYSTEM** in strict conformity with the plans and specifications for the following lump sum.

We, the undersigned, propose to do all the work and furnish all the labor, physical plant and materials necessary for the work set forth in the Bidding Documents, titled ARROWHEAD WATER RECLAMATION FACILITY MISCELLANEOUS IMPROVEMENTS - SUPPLEMENTAL CLORINATION/DECHLORINATION DISINFECTION SYSTEM. We further declare that we have carefully read and examined the referenced Bidding Documents that we have made a personal examination of the site , that we understand the exact Scope of the Project, and by making the Bid, declare that we are in compliance with all the requirements thereof.

Base Bid:

The undersigned agrees to perform the work as described in the Contract Documents for the following lump sum price:

Three hundred, seventeen thousand & one hundred dollars (Written)

$ 317,100.00 (Figures)

Allowance for Construction Contingency:

FIFTY-THOUSAND AND 00/100 DOLLARS (Written)

$50,000.00 (Figures)

Total Base Bid including Contingency:

Three hundred sixty seven thousand & 100 dollars (Written)

$ 367,100.00 (Figures)

NOTE: IN CASE OF DISCREPANCY, THE AMOUNT SHOWN IN WORDS SHALL GOVERN.

The undersigned hereby declares that he has visited the site(s) and has carefully examined the original contract documents, on file with the City, relating to the work covered by the above bid or bids. This bid proposal is based on those contract documents and the specifications and plans contained therein.

Upon receipt of notice of the acceptance of this bid, we will execute the formal contract attached within ten (10) days.

The undersigned has checked carefully all the above figures and understands that the City of Glendale, Arizona, will not be responsible for any errors or omissions on the part of the undersigned in making up this bid.

The undersigned understands that the Mayor and Council of the City of Glendale, Arizona, reserves the right to reject any or all bids or to waive any informalities in the bid.

Respectfully submitted,

Arizona Contractor's Classification and License No.
070935-A

FELIX CONSTRUCTION COMPANY
Contractor

By JOE L FELIX

Its MANAGER

309 E. 10TH DR MESA AZ 85210
(Complete business address)

Telephone Number: 4804640011

Fax Number 4804640078

Bidder shall signify receipt of all Addenda here (if any):

#1 - 4/28/11 , ADD#2 - 4/29/11

Failure to acknowledge receipt of Addenda shall render the bid proposal non-responsive and will be rejected.

Acknowledged by _____
Gentlemen: JOEL FELIX

Project 067013

CITY CLERK ORIGINAL

C-7705 06/14/2011

CONSTRUCTION AGREEMENT

This Construction Agreement ("Agreement") is entered into and effective between the CITY OF GLENDALE, an Arizona municipal corporation ("City"), and Felix Construction Company, an Arizona corporation ("Contractor") as of the 14 day of June, 2011.

RECITALS

A. City intends to undertake a project for the benefit of the public and with public funds that is more fully set forth in the **Notice to Contractors** and the attached **Exhibit A** ("Project");

B. City desires to retain the services of Contractor to perform those specific duties and produce the specific work as set forth in the Project, the plans and specifications, the **Information for Bidders,** and the **Maricopa Association of Governments** ("MAG") **General and Supplemental Conditions and Provisions;**

C. City and Contractor desire to memorialize their agreement with this document.

AGREEMENT

In consideration of the Recitals, which are confirmed as true and correct and incorporated by this reference, the mutual promises and covenants contained in this Agreement, and other good and valuable consideration, City and Contractor agree as follows:

1. Project.

1.1 Scope. Contractor will provide all services and material necessary to assure the Project is completed timely and efficiently consistent with Project requirements, including, but not limited to, working in close interaction and interfacing with City and its designated employees, and working closely with others, including other contractors, providers or consultants retained by City.

1.2 Documents. The following documents are, by this reference, entirely incorporated into this Agreement and attached Exhibits as though fully set forth herein:

(A) Notice to Contractors;
(B) Information for Bidders;
(C) MAG General Conditions, Supplemental General Conditions, Special and Technical Provisions;
(D) Proposal;
(E) Bid Bond;
(F) Payment Bond;
(G) Performance Bond;
(H) Certificate of Insurance;
(I) Appendix; and
(J) Plans and Addenda thereto.

Should a conflict exist between this Agreement (and its attachments), and any of the incorporated documents as listed above, the provisions of this Agreement shall govern.

1.3 Project Team.

(A) Project Manager. Contractor will designate an employee as Project Manager with sufficient training, knowledge, and experience to, in the City's opinion, to complete the project and handle all aspects of the Project such that the work produced by Contractor is consistent with applicable standards as detailed in this Agreement.

(B) Project Team.

(1) The Project manager and all other employees assigned to the project by Contractor will comprise the "Project Team."

(2) Project Manager will have responsibility for and will supervise all other employees assigned to the project by Contractor.

(C) Sub-contractors.

(1) Contractor may engage specific technical contractor (each a "Sub-contractor") to furnish certain service functions.

(2) Contractor will remain fully responsible for Sub-contractor's services.

(3) Sub-contractors must be approved by the City, unless the Sub-contractor was previously mentioned in the response to the solicitation.

(4) Contractor shall certify by letter that contracts with Sub-contractors have been executed incorporating requirements and standards as set forth in this Agreement.

2. **Schedule.** The Project will be undertaken in a manner that ensures it is completed in a timely and efficient manner. If not otherwise stated in **Exhibit A**, the Project shall be completed by no later than one hundred fifty (150) consecutive calendar days from and including the date of the Notice to Proceed.

3. **Contractor's Work.**

3.1 **Standard.** Contractor must perform services in accordance with the standards of due diligence, care, and quality prevailing among contractors having substantial experience with the successful furnishing of services and materials for projects that are equivalent in size, scope, quality, and other criteria under the Project and identified in this Agreement.

3.2 **Licensing.** Contractor warrants that:

(A) Contractor and Sub-contractors will hold all appropriate and required licenses, registrations and other approvals necessary for the lawful furnishing of services ("Approvals"); and

(B) Neither Contractor nor any Sub-contractor has been debarred or otherwise legally excluded from contracting with any federal, state, or local governmental entity ("Debarment").

(1) City is under no obligation to ascertain or confirm the existence or issuance of any Approvals or Debarments or to examine Contractor's contracting ability.

(2) Contractor must notify City immediately if any Approvals or Debarment changes during the Agreement's duration and the failure of the Contractor to notify City as required will constitute a material default of this Agreement.

3.3 **Compliance.** Services and materials will be furnished in compliance with applicable federal, state, county and local statutes, rules, regulations, ordinances, building codes, life safety codes, or other standards and criteria designated by City.

3.4 **Coordination; Interaction.**

(A) If the City determines that the Project requires the coordination of professional services or other providers, Contractor will work in close consultation with City to proactively interact with any other contractors retained by City on the Project ("Coordinating Entities").

(B) Subject to any limitations expressly stated in the budget, Contractor will meet to review the Project, schedules, budget, and in-progress work with Coordinating Entities and the City as often and for durations as City reasonably considers necessary in order to ensure the timely work delivery and Project completion.

(C) If the Project does not involve Coordinating Entities, Contractor will proactively interact with

any other contractors when directed by City to obtain or disseminate timely information for the proper execution of the Project.

3.5 **Hazardous Substances.** Contractor is responsible for the appropriate handling, disposal of, and if necessary, any remediation and all losses and damages to the City, associated with the use or release of hazardous substances by Contractor in connection with completion of the Project.

3.6 **Warranties.** At any time within two years after completion of the Project, Contractor must, at Contractor's sole expense and within 20 days of written notice from the City, uncover, correct and remedy all defects in Contractor's work. City will accept a manufacturer's warranty on approved equipment as satisfaction of the Contractor's warranty under this subsection.

3.7. **Bonds.** Upon execution of this Agreement, and if applicable, Contractor must furnish Payment and Performance bonds as required under A.R.S. § 34-608.

4. Compensation for the Project.

4.1 **Compensation.** Contractor's compensation for the Project, including those furnished by its Sub-contractors will not exceed $367,100.00, as specifically detailed in the Contractor's bid and set forth in **Exhibit B** ("Compensation").

4.2 **Change in Scope of Project.** The Compensation may be equitably adjusted if the originally contemplated scope of services as outlined in the Project is significantly modified by the City.

(A) Adjustments to the Scope or Compensation require a written amendment to this Agreement and may require City Council approval.

(B) Additional services which are outside the scope of the Project and not contained in this Agreement may not be performed by the Contractor without prior written authorization from the City.

5. Billings and Payment.

5.1 **Applications.**

(A) The Contractor will submit monthly invoices (each, a "Payment Application") to City's Project Manager and City will remit payments based upon the Payment Application as stated below.

(B) The period covered by each Payment Application will be one calendar month ending on the last day of the month.

5.2 **Payment.**

(A) After a full and complete Payment Application is received, City will process and remit payment within 30 days.

(B) Payment may be subject to or conditioned upon City's receipt of:

(1) Completed work generated by Contractor and its Sub-contractors; and

(2) Unconditional waivers and releases on final payment from Sub-contractors as City may reasonably request to assure the Project will be free of claims arising from required performances under this Agreement.

5.3 **Review and Withholding.** City's Project Manager will timely review and certify Payment Applications.

(A) If the Payment Application is rejected, the Project Manager will issue a written listing of the items not approved for payment.

(B) City may withhold an amount sufficient to pay expenses that City reasonably expects to incur in correcting the deficiency or deficiencies rejected for payment.

(C) Contractor will provide, by separate cover, and concurrent with the execution of this Agreement, all required financial information to the City, including City of Glendale Transaction Privilege License and Federal Taxpayer identification numbers.

(D) City will temporarily withhold Compensation amounts as required by A.R.S. 34-221(C).

6. Termination.

6.1 For Convenience. City may terminate this Agreement for convenience, without cause, by delivering a written termination notice stating the effective termination date, which may not be less than 15 days following the date of delivery.

(A) Contractor will be equitably compensated any services and materials furnished prior to receipt of the termination notice and for reasonable costs incurred.

(B) Contractor will also be similarly compensated for any approved effort expended and approved costs incurred that are directly associated with Project closeout and delivery of the required items to the City.

6.2 For Cause. City may terminate this Agreement for cause if Contractor fails to cure any breach of this Agreement within seven days after receipt of written notice specifying the breach.

(A) Contractor will not be entitled to further payment until after City has determined its damages. If City's damages resulting from the breach, as determined by City, are less than the equitable amount due but not paid Contractor for Service and Repair furnished, City will pay the amount due to Contractor, less City's damages.

(B) If City's direct damages exceed amounts otherwise due to Contractor, Contractor must pay the difference to City immediately upon demand; however, Contractor will not be subject to consequential damages more than $1,000,000 or the amount of this Agreement, whichever is greater.

7. Insurance.

7.1 Requirements. Contractor must obtain and maintain the following insurance ("Required Insurance"):

(A) Contractor and Sub-contractors. Contractor, and each Sub-contractor performing work or providing materials related to this Agreement must procure and maintain the insurance coverages described below (collectively, "Contractor's Policies"), until each Parties' obligations under this Agreement are completed.

(B) General Liability.

(1) Contractor must at all times relevant hereto carry a commercial general liability policy with a combined single limit of at least $2,000,000 per occurrence and $5,000,000 annual aggregate.

(2) Sub-contactors must at all times relevant hereto carry a general commercial liability policy with a combined single limit of at least $1,000,000 per occurrence.

(3) This commercial general liability insurance must include independent contractors' liability, contractual liability, broad form property coverage, products and completed operations, XCU hazards if requested by the City, and a separation of insurance provision.

(4) These limits may be met through a combination of primary and excess liability coverage.

(C) Auto. A business auto policy providing a liability limit of at least $1,000,000 per accident for Contractor and 1,000,000 per accident for Sub-contractors and covering owned, non-owned and hired automobiles.

(D) Workers' Compensation and Employer's Liability. A workers' compensation and employer's

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(2) Sub-contactors must at all times relevant hereto carry a general commercial liability policy with a combined single limit of at least $1,000,000 per occurrence.

(3) This commercial general liability insurance must include independent contractors' liability, contractual liability, broad form property coverage, products and completed operations, XCU hazards if requested by the City, and a separation of insurance provision.

(4) These limits may be met through a combination of primary and excess liability coverage.

(C) Auto. A business auto policy providing a liability limit of at least $1,000,000 per accident for Contractor and 1,000,000 per accident for Sub-contractors and covering owned, non-owned and hired automobiles.

(D) Workers' Compensation and Employer's Liability. A workers' compensation and employer's

liability policy providing at least the minimum benefits required by Arizona law.

(E) Equipment Insurance. Contractor must secure, pay for, and maintain all-risk insurance as necessary to protect the City against loss of owned, non-owned, rented or leased capital equipment and tools, equipment and scaffolding, staging, towers and forms owned or rented by Contractor or its Sub-contractors.

(F) Notice of Changes. Contractor's Policies must provide for not less than 30 days' advance written notice to City Representative of:

(1) Cancellation or termination of Contractor or Sub-contractor's Policies;

(2) Reduction of the coverage limits of any of Contractor or and Sub-contractor's Policies; and

(3) Any other material modification of Contractor or Sub-contractor's Policies related to this Agreement.

(G) Certificates of Insurance.

(1) Within 10 business days after the execution of the Agreement, Contractor must deliver to City Representative certificates of insurance for each of Contractor and Sub-contractor's Policies, which will confirm the existence or issuance of Contractor and Sub-contractor's Policies in accordance with the provisions of this section, and copies of the endorsements of Contractor and Sub-contractor's Policies in accordance with the provisions of this section.

(2) City is and will be under no obligation either to ascertain or confirm the existence or issuance of Contractor and Sub-contractor's Policies, or to examine Contractor and Sub-contractor's Policies, or to inform Contractor or Sub-contractor in the event that any coverage does not comply with the requirements of this section.

(3) Contractor's failure to secure and maintain Contractor Policies and to assure Sub-contractor policies as required will constitute a material default under this Agreement.

(H) Other Contractors or Vendors.

(1) Other contractors or vendors that may be contracted by Contractor with in connection with the Project must procure and maintain insurance coverage as is appropriate to their particular agreement.

(2) This insurance coverage must comply with the requirements set forth above for Contractor's Policies (e.g., the requirements pertaining to endorsements to name the parties as additional insured parties and certificates of insurance).

(I) Policies. Except with respect to workers' compensation and employer's liability coverages, the City must be named and properly endorsed as additional insureds on all liability policies required by this section.

(1) The coverage extended to additional insureds must be primary and must not contribute with any insurance or self insurance policies or programs maintained by the additional insureds.

(2) All insurance policies obtained pursuant to this section must be with companies legally authorized to do business in the State of Arizona and acceptable to all parties.

7.2 Sub-contractors.

(A) Contractor must also cause its Sub-contractors to obtain and maintain the Required Insurance.

(B) City may consider waiving these insurance requirements for a specific Sub-contractor if City is satisfied the amounts required are not commercially available to the Sub-contractor and the insurance the Sub-contractor does have is appropriate for the Sub-contractor's work under this

Agreement.

(C) Contractor and Sub-contractors must provide to the City proof of Required Insurance whenever requested.

7.3 Indemnification.

(A) To the fullest extent permitted by law, Contractor must defend, indemnify, and hold harmless City and its elected officials, officers, employees and agents (each, an "Indemnified Party," collectively, the "Indemnified Parties"), for, from, and against any and all claims, demands, actions, damages, judgments, settlements, personal injury (including sickness, disease, death, and bodily harm), property damage (including loss of use), infringement, governmental action and all other losses and expenses, including attorneys' fees and litigation expenses (each, a "Demand or Expense"; collectively, "Demands or Expenses") asserted by a third-party (i.e. a person or entity other than City or Contractor) and that arises out of or results from the breach of this Agreement by the Contractor or the Contractor's negligent actions, errors or omissions (including any Sub-contractor or other person or firm employed by Contractor), whether sustained before or after completion of the Project.

(B) This indemnity and hold harmless policy applies even if a Demand or Expense is in part due to the Indemnified Party's negligence or breach of a responsibility under this Agreement, but in that event, Contractor shall be liable only to the extent the Demand or Expense results from the negligence or breach of a responsibility of Contractor or of any person or entity for whom Contractor is responsible.

(C) Contractor is not required to indemnify any Indemnified Parties for, from, or against any Demand or Expense resulting from the Indemnified Party's sole negligence or other fault solely attributable to the Indemnified Party.

7.4 **Waiver of Subrogation.** Contractor waives, and will require any Subcontractor to waive, all rights of subrogation against the City to the extent of all losses or damages covered by any policy of insurance.

8. Immigration Law Compliance.

8.1 Contractor, and on behalf any subcontractor, warrants, to the extent applicable under A.R.S. § 41-4401, compliance with all federal immigration laws and regulations that relate to their employees as well as compliance with A.R.S. § 23-214(A) which requires registration and participation with the E-Verify Program.

8.2 Any breach of warranty under subsection 8.1 above is considered a material breach of this Agreement and is subject to penalties up to and including termination of this Agreement.

8.3 City retains the legal right to inspect the papers of any Contractor or subcontractor employee who performs work under this Agreement to ensure that the Contractor or any subcontractor is compliant with the warranty under subsection 8.1 above.

8.4 City may conduct random inspections, and upon request of City, Contractor shall provide copies of papers and records of Contractor demonstrating continued compliance with the warranty under subsection 8.1 above. Contractor agrees to keep papers and records available for inspection by the City during normal business hours and will cooperate with City in exercise of its statutory duties and not deny access to its business premises or applicable papers or records for the purposes of enforcement of this section 8.

8.5 Contractor agrees to incorporate into any subcontracts under this Agreement the same obligations imposed upon Contractor and expressly accrue those obligations directly to the benefit of the City. Contractor also agrees to require any subcontractor to incorporate into each of its own subcontracts under this Agreement the same obligations above and expressly accrue those obligations to the benefit of the City.

8.6 Contractor's warranty and obligations under this section to the City is continuing throughout the term of this Agreement or until such time as the City determines, in its sole discretion, that Arizona law has been modified in that compliance with this section is no longer a requirement.

8.7 The "E-Verify Program" above means the employment verification program administered by the United States Department of Homeland Security, the Social Security Administration, or any successor program.

9. Conflict. Contractor acknowledges this Agreement is subject to A.R.S. § 38-511, which allows for cancellation of this Agreement in the event any person who is significantly involved in initiating, negotiating, securing, drafting, or creating the Agreement on City's behalf is also an employee, agent, or consultant of any other party to this Agreement.

10. Prohibitions. Contractor certifies under A.R.S. §§ 35-391 *et seq.* and 35-393 *et seq.*, that it does not have, and during the term of this Agreement will not have "scrutinized" business operations, as defined in the preceding statutes, in the countries of Sudan or Iran.

11. Non-Discrimination Policies. Contractor must not discriminate against any employee or applicant for employment on the basis of race, religion, color sex or national origin. Contractor must develop, implement and maintain non-discrimination policies and post the policies in conspicuous places visible to employees and applicants for employment. Contractor will require any Sub-contractor to be bound to the same requirements as stated within this section.

12. Notices.

12.1 A notice, request or other communication that is required or permitted under this Agreement (each a "Notice") will be effective only if:

(A) The Notice is in writing, and

(B) Delivered in person or by private express overnight delivery service (delivery charges prepaid), certified or registered mail (return receipt requested).

(C) Notice will be deemed to have been delivered to the person to whom it is addressed as of the date of receipt, if:

(1) Received on a business day, or before 5:00 p.m., at the address for Notices identified for the Party in this Agreement by U.S. Mail, hand delivery, or overnight courier on or before 5:00 p.m.; or

(2) As of the next business day after receipt, if received after 5:00 p.m.

(D) The burden of proof of the place and time of delivery is upon the Party giving the Notice.

(E) Digitalized signatures and copies of signatures will have the same effect as original signatures.

12.2 **Representatives.**

(A) Contractor. Contractor's representative ("Contractor's Representative") authorized to act on Contractor's behalf with respect to the Project, and his or her address for Notice delivery is:

Joel L. Felix
Felix Construction Company
309 E. 10th Drive
Mesa, AZ 85210

(B) City. City's representative ("City's Representative") authorized to act on City's behalf, and his or her address for Notice delivery is:

City of Glendale
Attn: Arif Rahman
5850 West Glendale Avenue
Glendale, Arizona 85301

With required copies to:

City of Glendale City of Glendale

City Manager
5850 West Glendale Avenue
Glendale, Arizona 85301

City Attorney
5850 West Glendale Avenue
Glendale, Arizona 85301

(C) Concurrent Notices.

(1) All notices to City's representative must be given concurrently to City Manager and City Attorney.

(2) A notice will not be considered to have been received by City's representative until the time that it has also been received by City Manager and City Attorney.

(3) City may appoint one or more designees for the purpose of receiving notice by delivery of a written notice to Contractor identifying the designee(s) and their respective addresses for notices.

(D) **Changes.** Contractor or City may change its representative or information on Notice, by giving Notice of the change in accordance with this section at least ten days prior to the change.

13. **Financing Assignment.** City may assign this Agreement to any City-affiliated entity, including a non-profit corporation or other entity whose primary purpose is to own or manage the Project.

14. **Entire Agreement; Survival; Counterparts; Signatures.**

14.1 Integration. This Agreement contains, except as stated below, the entire agreement between City and Contractor and supersedes all prior conversations and negotiations between the parties regarding the Project or this Agreement.

(A) Neither Party has made any representations, warranties or agreements as to any matters concerning the Agreement's subject matter.

(B) Representations, statements, conditions, or warranties not contained in this Agreement will not be binding on the parties.

(C) Any solicitation, addendums and responses submitted by the Contractor are incorporated fully into this Agreement as Exhibit A. Any inconsistency between Exhibit A and this Agreement will be resolved by the terms and conditions stated in this Agreement.

14.2 Interpretation.

(A) The parties fairly negotiated the Agreement's provisions to the extent they believed necessary and with the legal representation they deemed appropriate.

(B) The parties are of equal bargaining position and this Agreement must be construed equally between the parties without consideration of which of the parties may have drafted this Agreement.

(C) The Agreement will be interpreted in accordance with the laws of the State of Arizona.

14.3 Survival. Except as specifically provided otherwise in this Agreement each warranty, representation, indemnification and hold harmless provision, insurance requirement, and every other right, remedy and responsibility of a Party, will survive completion of the Project, or the earlier termination of this Agreement.

14.4 Amendment. No amendment to this Agreement will be binding unless in writing and executed by the parties. Any amendment may be subject to City Council approval.

14.5 Remedies. All rights and remedies provided in this Agreement are cumulative and the exercise of any one or more right or remedy will not affect any other rights or remedies under this Agreement or applicable law.

14.6 Severability. If any provision of this Agreement is voided or found unenforceable, that determination

will not affect the validity of the other provisions, and the voided or unenforceable provision will be reformed to conform to applicable law.

14.7 **Counterparts.** This Agreement may be executed in counterparts, and all counterparts will together comprise one instrument.

15. **Dispute Resolution.** Each claim, controversy and dispute ("Dispute") between Contractor and City will be resolved in accordance with Exhibit C. The final determination will be made by the City.

16. **Exhibits.** The following exhibits, with reference to the term in which they are first referenced, are incorporated by this reference.

Exhibit A	Project
Exhibit B	Compensation
Exhibit C	Dispute Resolution

The parties enter into this Agreement as of the date shown above.

City of Glendale,
an Arizona municipal corporation

By: Ed Beasley
Its: City Manager

ATTEST:

City Clerk (SEAL)

APPROVED AS TO FORM:

City Attorney

FELIX CONSTRUCTION COMPANY
an Arizona corporation

By: ~~Joel L. Felix~~ Archie Lopez
Its: ~~Director~~ President

WOMEN-OWNED/MINORITY BUSINESS [ ] YES [✓] NO
CITY OF GLENDALE TRANSACTION PRIVILEGE TAX NO. [redacted]
FEDERAL TAXPAYER IDENTIFICATION NO. [redacted]

EXHIBIT A
CONSTRUCTION AGREEMENT

PROJECT

The work consists of construction of supplemental chlorination/dechlorination systems to include a new sodium bisulfite facility, additional sodium hypochlorite feed pumps, sample pumps, chlorine residual analyzers, associated yard piping, and electrical/instrumentation equipment.

EXHIBIT B
CONSTRUCTION AGREEMENT

COMPENSATION

METHOD AND AMOUNT OF COMPENSATION

By bid, including all services, materials and costs.

NOT-TO-EXCEED AMOUNT

The total amount of compensation paid to Contractor for full completion of all work required by the Project during the entire term of the Project must not exceed $367,100.00.

DETAILED PROJECT COMPENSATION

Per Page 8 of the Bid Schedule.

EXHIBIT C
CONSTRUCTION AGREEMENT

DISPUTE RESOLUTION

1. Disputes.

1.1 Commitment. The parties commit to resolving all disputes promptly, equitably, and in a good-faith, cost-effective manner.

1.2 Application. The provisions of this Exhibit will be used by the parties to resolve all controversies, claims, or disputes ("Dispute") arising out of or related to this Agreement-including Disputes regarding any alleged breaches of this Agreement.

1.3 Initiation. A party may initiate a Dispute by delivery of written notice of the Dispute, including the specifics of the Dispute, to the Representative of the other party as required in this Agreement.

1.4 Informal Resolution. When a Dispute notice is given, the parties will designate a member of their senior management who will be authorized to expeditiously resolve the Dispute.

(A) The parties will provide each other with reasonable access during normal business hours to any and all non-privileged records, information and data pertaining to any Dispute in order to assist in resolving the Dispute as expeditiously and cost effectively as possible;

(B) The parties' senior managers will meet within 10 business days to discuss and attempt to resolve the Dispute promptly, equitably, and in a good faith manner, and

(C) The Senior Managers will agree to subsequent meetings if both parties agree that further meetings are necessary to reach a resolution of the Dispute.

2. Arbitration.

2.1 Rules. If the parties are unable to resolve the Dispute by negotiation within 30 days from the Dispute notice, and unless otherwise informal discussions are extended by the mutual agreement, the Dispute will be decided by binding arbitration in accordance with Construction Industry Rules of the AAA, as amended herein. Although the arbitration will be conducted in accordance with AAA Rules, it will not be administered by the AAA, but will be heard independently.

(A) The parties will exercise best efforts to select an arbitrator within 5 business days after agreement for arbitration. If the parties have not agreed upon an arbitrator within this period, the parties will submit the selection of the arbitrator to one of the principals of the mediation firm of Scott & Skelly, LLC, who will then select the arbitrator. The parties will equally share the fees and costs incurred in the selection of the arbitrator.

(B) The arbitrator selected must be an attorney with at least 15 years experience with commercial construction legal matters in Maricopa County, Arizona, be independent, impartial, and not have engaged in any business for or adverse to either Party for at least 10 years.

2.2 Discovery. The extent and the time set for discovery will be as determined by the arbitrator. Each Party must, however, within ten (10) days of selection of an arbitrator deliver to the other Party copies of all documents in the delivering party's possession that are relevant to the dispute.

2.3 Hearing. The arbitration hearing will be held within 90 days of the appointment of the arbitrator. The arbitration hearing, all proceedings, and all discovery will be conducted in Glendale, Arizona unless otherwise agreed by the parties or required as a result of witness location. Telephonic hearings and other reasonable arrangements may be used to minimize costs.

2.4 Award. At the arbitration hearing, each Party will submit its position to the arbitrator, evidence to support that position, and the exact award sought in this matter with specificity. The arbitrator must select the award sought by one of the parties as the final judgment and may not independently alter or modify the awards sought by the parties, fashion any remedy, or make any equitable order. The arbitrator has no authority to consider or award punitive damages.

2.5 Final Decision. The Arbitrator's decision should be rendered within 15 days after the arbitration hearing is concluded. This decision will be final and binding on the Parties.

2.6 Costs. The prevailing party may enter the arbitration in any court having jurisdiction in order to convert it to a judgment. The non-prevailing party shall pay all of the prevailing party's arbitration costs and expenses, including reasonable attorney's fees and costs.

3. Services to Continue Pending Dispute. Unless otherwise agreed to in writing, Contractor must continue to perform and maintain progress of required services during any Dispute resolution or arbitration proceedings, and City will continue to make payment to Contractor in accordance with this Agreement.

4. Exceptions.

4.1 Third Party Claims. City and Contractor are not required to arbitrate any third-party claim, cross-claim, counter claim, or other claim or defense of a third-party who is not obligated by contract to arbitrate disputes with City and Contractor.

4.2 Liens. City or Contractor may commence and prosecute a civil action to contest a lien or stop notice, or enforce any lien or stop notice, but only to the extent the lien or stop notice the Party seeks to enforce is enforceable under Arizona Law, including, without limitation, an action under A.R.S. § 33-420, without the necessity of initiating or exhausting the procedures of this Exhibit.

4.3 Governmental Actions. This Exhibit does not apply to, and must not be construed to require arbitration of, any claims, actions or other process filed or issued by City of Glendale Building Safety Department or any other agency of City acting in its governmental permitting or other regulatory capacity.

INDIVIDUAL SURETIES WILL NOT BE ACCEPTED
STATUTORY PERFORMANCE BOND PURSUANT TO TITLE 34,
CHAPTER 2, ARTICLE 2, OF THE ARIZONA REVISED STATUTES
(Penalty of this bond must be 100% of the Contract Amount)

BOND NO: 105606731

KNOW ALL MEN BY THESE PRESENTS:

That Felix Construction Company (hereinafter called the Principal), as Principal, and *, a corporation organized and existing under the laws of the State of CT with its principal office in the City of Hartford, (hereinafter called the Surety), as Surety, are held and firmly bound unto the City of Glendale, a municipal corporation, (hereinafter called the Obligee), in the amount of Three Hundred Sixty-Seven Thousand, One Hundred--Dollars ($ 367,100.00), for the payment whereof; the said Principal and Surety bind themselves, and their heirs, administrators, successors and assigns, jointly and severally, firmly by these presents. *Travelers Casualty and Surety Company of America

WHEREAS, The Principal has entered into a certain written contract with the Obligee, dated the 14 day of June 2011, to construct **PROJECT 067013 - ARROWHEAD WATER RECLAMATION FACILITY MISCELLANEOUS IMPROVEMENTS - SUPPLEMENTAL CLORINATION/DECHLORINATION DISINFECTION SYSTEM**, which contract is hereby referred to and made a part hereof as fully and to the same extent as if copied at length herein.

NOW, THEREFORE, THE CONDITION OF THIS OBLIGATION IS SUCH, that if the said Principal shall faithfully perform and fulfill all undertakings, covenants, terms, conditions and agreements of said contract during the original term of said contract any extension thereof, with or without notice to the Surety, and during the life of any guaranty required under the contract and shall also perform and fulfill all the undertakings, covenants, terms, conditions, and agreements of any and all duly authorized modifications of said contract that may hereafter be made, notice of which modifications to the Surety being hereby waived; then the above obligation shall be void, otherwise to remain in full force and effect.

PROVIDED, HOWEVER, that this bond is executed pursuant to the provisions of Title 34, Chapter 2, Article 2, of the Arizona Revised Statutes, and all liabilities on this bond shall be determined in accordance with the provisions of said Title, Chapter, and Article, to the extent as if it were copied at length herein.

The prevailing party or any party which recovers judgment on this bond shall be entitled to such reasonable attorney's fees as may be fixed by the court or a judge thereof.

Witness our hands this 29th day of June, 2011.

Felix Construction Company
Principal Seal

By _____

Travelers Casualty and Surety Company of America
Surety Seal

By _____
Susan A. Toomey, Attorney-in-Fact
CBI Bonding, Inc.
535 E. McKellips Rd,#129,Mesa, AZ 85203
Agency Address

Telephone Number: (480) 968-0100

DUPLICATE ORIGINAL

INDIVIDUAL SURETIES WILL NOT BE ACCEPTED

STATUTORY PAYMENT BOND PURSUANT TO TITLE 34,
CHAPTER 2, ARTICLE 2, OF THE ARIZONA REVISED STATUTES
(Penalty of this bond must be 100% of the Contract Amount)

BOND NO: 105606731

KNOW ALL MEN BY THESE PRESENTS:

That, Felix Construction Company (hereinafter called the Principal), as Principal, and * , a corporation organized and existing under the laws of the State of CT with its principal office in the City of Hartford, (hereinafter called the Surety), as Surety, are held and firmly bound unto the City of Glendale, a municipal corporation, (hereinafter called the Obligee), in the amount of ** Dollars ($367,100.00), for the payment whereof; the said Principal and Surety bind themselves, and their heirs, administrators, successors and assigns, jointly and severally, firmly by these presents.

*Travelers Casualty and Surety Company of America

**Three Hundred Sixty-Seven Thousand, One Hundred & No/100

WHEREAS, The Principal has entered into a certain written contract with the Obligee, dated the day of _____, 20____, to construct **PROJECT 067013 - ARROWHEAD WATER RECLAMATION FACILITY MISCELLANEOUS IMPROVEMENTS - SUPPLEMENTAL CLORINATION/DECHLORINATION DISINFECTION SYSTEM** which contract is hereby referred to and made a part hereof as fully and to the same extent as if copied at length herein.

NOW, THEREFORE, THE CONDITION OF THIS OBLIGATION IS SUCH, that if the said Principal shall promptly pay all monies due to all persons supplying labor or materials to him or his subcontractors in the prosecution of the work provided for in said Contract, then this obligation shall be void, otherwise to remain in full force and effect.

PROVIDED, HOWEVER, that this bond having been required of the said Principal in order to comply with the provisions of Title 34, Chapter 2, Article 2, of the Arizona Revised Statutes, all rights and remedies on this bond shall inure solely to such persons and shall be determined in accordance with the provisions, conditions, and limitations of said Title, Chapter and Article, to the same extent as if they were copied at length herein.

The prevailing party or any party which recovers judgment on this bond shall be entitled to such reasonable attorney's fees as may be fixed by the court or a judge thereof.

Witness our hands this 29th day of June, 20 11 .

Felix Construction Company
Principal Seal

By _____

Travelers Casualty and Surety Company
Surety of America Seal

By _____
Susan A. Toomey, Attorney-in-Fact
CBI Bonding, Inc.

535 E. McKellips Rd,#129,Mesa,AZ 85203
Agency Address

(480) 968-0100
Telephone _____

DUPLICATE ORIGINAL

WARNING: THIS POWER OF ATTORNEY IS INVALID WITHOUT THE RED BORDER

TRAVELERS

POWER OF ATTORNEY

Farmington Casualty Company
Fidelity and Guaranty Insurance Company
Fidelity and Guaranty Insurance Underwriters, Inc.
St. Paul Fire and Marine Insurance Company
St. Paul Guardian Insurance Company

St. Paul Mercury Insurance Company
Travelers Casualty and Surety Company
Travelers Casualty and Surety Company of America
United States Fidelity and Guaranty Company

Attorney-In Fact No. 222144 **Certificate No.** 003764583

KNOW ALL MEN BY THESE PRESENTS: That St. Paul Fire and Marine Insurance Company, St. Paul Guardian Insurance Company and St. Paul Mercury Insurance Company are corporations duly organized under the laws of the State of Minnesota, that Farmington Casualty Company, Travelers Casualty and Surety Company, and Travelers Casualty and Surety Company of America are corporations duly organized under the laws of the State of Connecticut, that United States Fidelity and Guaranty Company is a corporation duly organized under the laws of the State of Maryland, that Fidelity and Guaranty Insurance Company is a corporation duly organized under the laws of the State of Iowa, and that Fidelity and Guaranty Insurance Underwriters, Inc., is a corporation duly organized under the laws of the State of Wisconsin (herein collectively called the "Companies"), and that the Companies do hereby make, constitute and appoint

Barry Farr, Susan A. Toomey, Valerie Perez-Pacheco, and Andrew Farr

of the City of Mesa, State of Arizona, their true and lawful Attorney(s)-in-Fact, each in their separate capacity if more than one is named above, to sign, execute, seal and acknowledge any and all bonds, recognizances, conditional undertakings and other writings obligatory in the nature thereof on behalf of the Companies in their business of guaranteeing the fidelity of persons, guaranteeing the performance of contracts and executing or guaranteeing bonds and undertakings required or permitted in any actions or proceedings allowed by law.

WARNING: THIS POWER OF ATTORNEY IS INVALID WITHOUT THE RED BORDER

IN WITNESS WHEREOF, the Companies have caused this instrument to be signed and their corporate seals to be hereto affixed, this 14th day of July, 2010.

Farmington Casualty Company
Fidelity and Guaranty Insurance Company
Fidelity and Guaranty Insurance Underwriters, Inc.
St. Paul Fire and Marine Insurance Company
St. Paul Guardian Insurance Company

St. Paul Mercury Insurance Company
Travelers Casualty and Surety Company
Travelers Casualty and Surety Company of America
United States Fidelity and Guaranty Company

State of Connecticut
City of Hartford ss.

By: George W. Thompson
George W. Thompson, Senior Vice President

On this the 14th day of July, 2010, before me personally appeared George W. Thompson, who acknowledged himself to be the Senior Vice President of Farmington Casualty Company, Fidelity and Guaranty Insurance Company, Fidelity and Guaranty Insurance Underwriters, Inc., St. Paul Fire and Marine Insurance Company, St. Paul Guardian Insurance Company, St. Paul Mercury Insurance Company, Travelers Casualty and Surety Company, Travelers Casualty and Surety Company of America, and United States Fidelity and Guaranty Company, and that he, as such, being authorized so to do, executed the foregoing instrument for the purposes therein contained by signing on behalf of the corporations by himself as a duly authorized officer.

In Witness Whereof, I hereunto set my hand and official seal.
My Commission expires the 30th day of June, 2011.

Marie C. Tetreault
Marie C. Tetreault, Notary Public

58440-4-09 Printed in U.S.A.

WARNING: THIS POWER OF ATTORNEY IS INVALID WITHOUT THE RED BORDER

This Power of Attorney is granted under and by the authority of the following resolutions adopted by the Boards of Directors of Farmington Casualty Company, Fidelity and Guaranty Insurance Company, Fidelity and Guaranty Insurance Underwriters, Inc., St. Paul Fire and Marine Insurance Company, St. Paul Guardian Insurance Company, St. Paul Mercury Insurance Company, Travelers Casualty and Surety Company, Travelers Casualty and Surety Company of America, and United States Fidelity and Guaranty Company, which resolutions are now in full force and effect, reading as follows:

RESOLVED, that the Chairman, the President, any Vice Chairman, any Executive Vice President, any Senior Vice President, any Vice President, any Second Vice President, the Treasurer, any Assistant Treasurer, the Corporate Secretary or any Assistant Secretary may appoint Attorneys-in-Fact and Agents to act for and on behalf of the Company and may give such appointee such authority as his or her certificate of authority may prescribe to sign with the Company's name and seal with the Company's seal bonds, recognizances, contracts of indemnity, and other writings obligatory in the nature of a bond, recognizance, or conditional undertaking, and any of said officers or the Board of Directors at any time may remove any such appointee and revoke the power given him or her; and it is

FURTHER RESOLVED, that the Chairman, the President, any Vice Chairman, any Executive Vice President, any Senior Vice President or any Vice President may delegate all or any part of the foregoing authority to one or more officers or employees of this Company, provided that each such delegation is in writing and a copy thereof is filed in the office of the Secretary; and it is

FURTHER RESOLVED, that any bond, recognizance, contract of indemnity, or writing obligatory in the nature of a bond, recognizance, or conditional undertaking shall be valid and binding upon the Company when (a) signed by the President, any Vice Chairman, any Executive Vice President, any Senior Vice President or any Vice President, any Second Vice President, the Treasurer, any Assistant Treasurer, the Corporate Secretary or any Assistant Secretary and duly attested and sealed with the Company's seal by a Secretary or Assistant Secretary; or (b) duly executed (under seal, if required) by one or more Attorneys-in-Fact and Agents pursuant to the power prescribed in his or her certificate or their certificates of authority or by one or more Company officers pursuant to a written delegation of authority; and it is

FURTHER RESOLVED, that the signature of each of the following officers: President, any Executive Vice President, any Senior Vice President, any Vice President, any Assistant Vice President, any Secretary, any Assistant Secretary, and the seal of the Company may be affixed by facsimile to any Power of Attorney or to any certificate relating thereto appointing Resident Vice Presidents, Resident Assistant Secretaries or Attorneys-in-Fact for purposes only of executing and attesting bonds and undertakings and other writings obligatory in the nature thereof, and any such Power of Attorney or certificate bearing such facsimile signature or facsimile seal shall be valid and binding upon the Company and any such power so executed and certified by such facsimile signature and facsimile seal shall be valid and binding on the Company in the future with respect to any bond or understanding to which it is attached.

I, Kori M. Johanson, the undersigned, Assistant Secretary, of Farmington Casualty Company, Fidelity and Guaranty Insurance Company, Fidelity and Guaranty Insurance Underwriters, Inc., St. Paul Fire and Marine Insurance Company, St. Paul Guardian Insurance Company, St. Paul Mercury Insurance Company, Travelers Casualty and Surety Company, Travelers Casualty and Surety Company of America, and United States Fidelity and Guaranty Company do hereby certify that the above and foregoing is a true and correct copy of the Power of Attorney executed by said Companies, which is in full force and effect and has not been revoked.

WARNING: THIS POWER OF ATTORNEY IS INVALID WITHOUT THE RED BORDER

IN TESTIMONY WHEREOF, I have hereunto set my hand and affixed the seals of said Companies this 29th day of June, 20 11

Kori M. Johanson, Assistant Secretary

To verify the authenticity of this Power of Attorney, call 1-800-421-3880 or contact us at www.travelersbond.com. Please refer to the Attorney-In-Fact number, the above-named individuals and the details of the bond to which the power is attached.

CERTIFICATE OF LIABILITY INSURANCE

DATE (MM/DD/YYYY): 06/29/2011

THIS CERTIFICATE IS ISSUED AS A MATTER OF INFORMATION ONLY AND CONFERS NO RIGHTS UPON THE CERTIFICATE HOLDER. THIS CERTIFICATE DOES NOT AFFIRMATIVELY OR NEGATIVELY AMEND, EXTEND OR ALTER THE COVERAGE AFFORDED BY THE POLICIES BELOW. THIS CERTIFICATE OF INSURANCE DOES NOT CONSTITUTE A CONTRACT BETWEEN THE ISSUING INSURER(S), AUTHORIZED REPRESENTATIVE OR PRODUCER, AND THE CERTIFICATE HOLDER.

IMPORTANT: If the certificate holder is an ADDITIONAL INSURED, the policy(ies)must be endorsed. If SUBROGATION IS WAIVED, subject to the terms and conditions of the policy, certain policies may require an endorsement. A statement on this certificate does not confer rights to the certificate holder in lieu of such endorsement(s).

PRODUCER

Willis of Arizona, Inc.
26 Century Blvd.
P. O. Box 305191
Nashville, TN 37230-5191

CONTACT NAME:
PHONE (A/C, NO, EXT): 877-945-7378 FAX (A/C, NO): 888-467-2378
E-MAIL ADDRESS: certificates@willis.com

INSURER(S)AFFORDING COVERAGE	NAIC #
INSURER A: Westfield Insurance Company	24112-001
INSURER B: St. Paul Fire & Marine Ins. Co.	24767-001
INSURER C: Greenwich Insurance Company	22322-002
INSURER D:	
INSURER E:	
INSURER F:	

INSURED

Felix Construction Company
309 E. 10th Drive
Mesa, AZ 85210

COVERAGES **CERTIFICATE NUMBER:** 16176574 **REVISION NUMBER:** See Remarks

THIS IS TO CERTIFY THAT THE POLICIES OF INSURANCE LISTED BELOW HAVE BEEN ISSUED TO THE INSURED NAMED ABOVE FOR THE POLICY PERIOD INDICATED. NOTWITHSTANDING ANY REQUIREMENT, TERM OR CONDITION OF ANY CONTRACT OR OTHER DOCUMENT WITH RESPECT TO WHICH THIS CERTIFICATE MAY BE ISSUED OR MAY PERTAIN. THE INSURANCE AFFORDED BY THE POLICIES DESCRIBED HEREIN IS SUBJECT TO ALL THE TERMS, EXCLUSIONS AND CONDITIONS OF SUCH POLICIES. LIMITS SHOWN MAY HAVE BEEN REDUCED BY PAID CLAIMS.

INSR LTR	TYPE OF INSURANCE	ADD'L INSRD	SUBR WVD	POLICY NUMBER	POLICY EFF (MM/DD/YYYY)	POLICY EXP (MM/DD/YYYY)	LIMITS	
A	GENERAL LIABILITY	Y		CMM1618295	4/7/2011	4/7/2012	EACH OCCURRENCE	$ 1,000,000
	[X] COMMERCIAL GENERAL LIABILITY						DAMAGE TO RENTED PREMISES (Ea occurence)	$ 300,000
	[ ] CLAIMS-MADE [X] OCCUR						MED EXP (Any one person)	$ 10,000
							PERSONAL & ADV INJURY	$ 1,000,000
							GENERAL AGGREGATE	$ 2,000,000
	GEN'L AGGREGATE LIMIT APPLIES PER:						PRODUCTS - COMP/OP AGG	$ 2,000,000
	[ ] POLICY [X] PRO-JECT [ ] LOC							$
A	AUTOMOBILE LIABILITY	Y		CMM1618295	4/7/2011	4/7/2012	COMBINED SINGLE LIMIT (Ea accident)	$ 1,000,000
	[X] ANY AUTO						BODILY INJURY(Per person)	$
	[ ] ALL OWNED AUTOS [ ] SCHEDULED AUTOS						BODILY INJURY(Per accident)	$
	[ ] HIRED AUTOS [ ] NON-OWNED AUTOS						PROPERTY DAMAGE (Per accident)	$
								$
B	[X] UMBRELLA LIAB [X] OCCUR			QK08300917	4/7/2011	4/7/2012	EACH OCCURRENCE	$ 5,000,000
	[ ] EXCESS LIAB [ ] CLAIMS-MADE						AGGREGATE	$ 5,000,000
	[ ] DED [X] RETENTION $ 10,000							$
	WORKERS COMPENSATION AND EMPLOYERS' LIABILITY Y/N						[ ] WC STATU-TORY LIMITS [ ] OTH-ER	
	ANY PROPRIETOR/PARTNER/EXECUTIVE OFFICER/MEMBER EXCLUDED? [ ]	N/A					E.L. EACH ACCIDENT	$
	(Mandatory in NH) If yes, describe under DESCRIPTION OF OPERATIONS below						E.L. DISEASE - EA EMPLOYEE	$
							E.L. DISEASE - POLICY LIMIT	$
C	Professional & Pollution			PEC001535007	4/7/2011	4/7/2012	$1,000,000 Each Claim $2,000,000 Aggregate $ 50,000 Retention	

DESCRIPTION OF OPERATIONS / LOCATIONS / VEHICLES (Attach Acord 101, Additonal Remarks Schedule, if more space is required)

THIS VOIDS AND REPLACES PREVIOUSLY ISSUED CERTIFICATE DATED: 6/28/2011 WITH ID: 16155575

Re: Glendale Arrowhead CHLDR / DECHLDR

Umbrella/Excess Liability coverage is following form to all underlying policies, including Worker's Compensation, except for Contractors Professional/Pollution Liability.

CERTIFICATE HOLDER

City of Glendale, Arizona
Attn: Engineering Department
5850 West Glendale Ave.
Glendale, AZ 85301

CANCELLATION

SHOULD ANY OF THE ABOVE DESCRIBED POLICIES BE CANCELLED BEFORE THE EXPIRATION DATE THEREOF, NOTICE WILL BE DELIVERED IN ACCORDANCE WITH THE POLICY PROVISIONS.

AUTHORIZED REPRESENTATIVE

Greg Gom

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AGENCY CUSTOMER ID: 030143

LOC#: _____

ADDITIONAL REMARKS SCHEDULE

AGENCY	NAMED INSURED
Willis of Arizona, Inc.	Felix Construction Company 309 E. 10th Drive Mesa, AZ 85210
POLICY NUMBER See First Page	
CARRIER: See First Page / NAIC CODE	EFFECTIVE DATE: See First Page

ADDITIONAL REMARKS

THIS ADDITIONAL REMARKS FORM IS A SCHEDULE TO ACORD FORM,
FORM NUMBER: 25 FORM TITLE: CERTIFICATE OF LIABILITY INSURANCE

It is agreed that City of Glendale, Arizona is included as an Additional Insured as respects to General and Auto Liability, per written contract.

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THIS ENDORSEMENT CHANGES THE POLICY. PLEASE READ IT CAREFULLY.

ADDITIONAL INSURED – OWNERS, LESSEES OR CONTRACTORS - AUTOMATIC STATUS WHEN REQUIRED IN CONSTRUCTION AGREEMENT WITH YOU

This endorsement modifies insurance provided under the following:

COMMERCIAL GENERAL LIABILITY COVERAGE PART

A. **Section II – Who Is An Insured** is amended to include as an additional insured any person or organization for whom you are performing operations when you and such person or organization have agreed in writing in a contract or agreement that such person or organization be added as an additional insured on your policy. Such person or organization is an additional insured only with respect to liability for "bodily injury", "property damage" or "personal and advertising injury" caused, in whole or in part, by:

1. Your acts or omissions; or
2. The acts or omissions of those acting on your behalf;

In the performance of your ongoing operations for the additional insured.

A person's or organization's status as an additional insured under this endorsement ends when your operations for that additional insured are completed.

B. With respect to the insurance afforded to these additional insureds, the following additional exclusions apply:

This insurance does not apply to:

1. "Bodily injury", "property damage" or "personal and advertising injury" arising out of the rendering of, or the failure to render, any professional architectural, engineering or surveying services, including:

a. The preparing, approving, or failing to prepare or approve, maps, shop drawings, opinions, reports, surveys, field orders, change orders or drawings and specifications; and

b. Supervisory, inspection, architectural or engineering activities.

2. "Bodily injury" or "property damage" occurring after:

a. All work, including materials, parts or equipment furnished in connection with such work, on the project (other than service, maintenance or repairs) to be performed by or on behalf of the additional insured(s) at the site of the covered operations has been completed; or

b. That portion of "your work" out of which the injury or damage arises has been put to its intended use by any person or organization other than another contractor or subcontractor engaged in performing operations for a principal as a part of the same project.

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THIS ENDORSEMENT CHANGES THE POLICY. PLEASE READ IT CAREFULLY.

BUSINESS AUTO EXPANDED PLUS COVERAGE ENDORSEMENT

This endorsement modifies insurance provided under the following:

BUSINESS AUTO COVERAGE FORM

1. **BUSINESS AUTO COVERAGE FORM CA 0001 IS MODIFIED AS FOLLOWS:**

SECTION II - LIABILITY COVERAGE, Item A. 1. Coverage, Who Is An Insured is amended to include the following additional paragraphs:

d. Any legally incorporated subsidiary of yours in which you own more than 50% of the voting stock on the effective date of this coverage form.

However, "insured" does not include any subsidiary that is an "insured" under any other liability policy or would be an "insured" under such a policy but for its termination or the exhaustion of its limits of insurance.

e. Any organization you newly acquire or form, other than a partnership or joint venture, and over which you maintain ownership or a majority interest. However, coverage under this provision:

(1) Does not apply if the organization you acquire or form is an "insured" under another liability policy or would be "insured" under such a policy but for its termination or the exhaustion of its limits of insurance;

(2) Does not apply to "bodily injury" or "property damage" that occurred before you acquired or formed the organization; and

(3) Is afforded only for the first 180 days after you acquire or form the organization or until the end of the policy period, whichever comes first.

f. Any person or organization with whom you agreed in writing in a contract, agreement or permit, to provide insurance such as is afforded under this policy.

This provision only applies if the written contract or agreement has been executed or permit has been issued, prior to the "bodily injury" or "property damage".

g. Any "employees" of yours while using a covered "auto" you do not own, hire or borrow that "auto".

SECTION II - LIABILITY COVERAGE, subparagraphs **(2)** and **(4)** of Item **A. 2. a. Coverage Extensions, Supplementary Payments** are deleted and replaced with the following:

(2) Up to $5,000 for cost of bail bonds (including bonds for related traffic law violations) required because of an "accident" we cover. We do not have to furnish these bonds.

(4) All reasonable expenses incurred by the "insured" at our request, including actual loss of earnings up to $500 per day because of time off from work.

SECTION II - LIABILITY COVERAGE, B. Exclusions, 5. Fellow Employee does not apply if the "bodily injury" results from the use of a covered "auto" you own or hire.

SECTION III - PHYSICAL DAMAGE COVERAGE is amended as follows:

Item **A. 4. Coverage, Coverage Extension** is deleted and replaced with the following:

4. **Coverage Extensions**

a. **Transportation Expenses**

We will pay up to $50 per day to a maximum of $1,000 for transportation expense incurred by you because of the total theft of a covered "auto" of the private passenger type. We will pay only for those covered "autos" for which you carry either Comprehensive or Specified Causes of Loss Coverage. We will pay for transportation expenses incurred during the period beginning 48 hours after the theft and ending, regardless of the policy's expiration, when the covered "auto" is returned to use or we pay for its "loss."

b. **Personal Effects**

We will pay up to $500 for the "loss" of your personal effects that are contained in a covered "auto" due to the total theft of the covered "auto." We will pay only for those personal effects that are contained in covered "autos" for which you carry either Comprehensive or Specified Causes of Loss Coverage.

Our payment for loss of or damage to personal effects will apply only on an excess basis over other collectible insurance.

Item **A. Coverage**, is amended to include the following additional coverage items:

We will pay the expense of returning a stolen covered "auto" to you.

5. **Hired Auto Physical Damage**

If Comprehensive, Specified Causes of Loss, or Collision coverages are provided under this policy, then we will provide the same coverage(s) for those "autos" that you lease, hire, rent or borrow from others. The most we will pay for any one "accident" or "loss" is $50,000 or Actual Cash Value or Cost of Repair, whichever is less, minus a deductible for each covered "auto" that is equal to the largest deductible on the schedule of "autos" applicable to any owned "auto" for that coverage. No deductible applies to "loss" caused by fire or lightning.

6. **Fire Department Service Charge**

When a fire department is called to save or protect a covered "auto", its equipment, its contents, or occupants from a covered cause of loss, we will pay up to $1000 for your liability for fire department service charges:

(1) Assumed by contract or agreement prior to loss; or

(2) Required by local ordinance.

No deductible applies to this additional coverage.

Under **Paragraph B. Exclusions** the following is added:

Mechanical breakdown does not apply to the accidental discharge of an airbag.

Item **B. Exclusions**, is amended to include the following:

Exclusions 4.c. and 4.d. do not apply to:

c. Cellular telephones and accessories used with such equipment, provided such equipment is permanently installed in the covered "auto" at the time of the "loss" or such equipment is removable from a housing unit which is permanently installed in the covered "auto" at the time of the "loss', and such equipment is designed to be solely operated by use of the power from the "auto's" electrical system, in or upon the covered "auto".

Item **C. Limits Of Insurance**, is amended to include the following:

3. For those businesses not shown in the Declarations as "auto" dealerships, the following provisions also apply:

a. In the event of a total loss to a covered "auto", secured by an original lease or loan agreement, in which the cost of repairs plus the salvage value exceeds the actual cash value at the time of "loss", the most we will pay is the greater of:

(1) The actual cash value of the covered "auto" at the time of "loss"; or

(2) The amount you owe under the terms of the original lease or loan agreement to which the covered "auto" is subject, reduced by:

(a) Overdue payments and associated financial penalties as of the date of "loss";

(b) The transfer or rollover of a previous outstanding lease or loan balance from another vehicle to the original lease or loan for the covered "auto";

(c) The dollar amount of any unrepaired damage which occurred prior to the date of a total loss, in which the cost of repairs plus the salvage value exceeds the actual cash value;

(d) All refunds paid or payable to you as a result of the early termination of the lease or loan agreement or, to the extent financed, as a result of the early termination of any warranty or extended service agreement on the covered "auto";

(e) Financial penalties imposed under the lease agreement for high mileage, excessive use or abnormal wear and tear; and

(f) Nonrefundable security deposits.

Item **D. Deductible** is deleted and replaced with the following:

D. *Deductible*

For each covered *"auto"*, our obligation to pay for, repair, return or replace damaged or stolen property will be reduced by the applicable deductible shown in the Declarations.

1. Any Comprehensive Coverage deductible shown in the Declarations does not apply to "loss" caused by fire or lightning.

2. Any Collision Coverage deductible amount shall not apply to loss caused by collision between your covered "auto" and an "auto", other than a covered "auto", provided:

   a. The loss to the covered "auto" is greater than the deductible amount; and

   b. The owner or operator of such other "auto" has been identified; and

   c. The owner or operator of such other "auto" is legally liable for the loss to your covered *"auto;"* and

   d. There is a valid Property Damage Liability Insurance Policy applicable at the time of the accident with respects to the person or organization legally responsible for such loss to the covered "auto."

3. No deductible shall apply to glass damage if the glass is repaired rather than replaced.

SECTION IV - BUSINESS AUTO CONDITIONS is amended as follows:

Item **A. Loss Conditions, 2. a. Duties In The Event Of Accident, Claim, Suit Or Loss** is amended to include the following paragraph:

This requirement applies when the *"accident,"* claim, *"suit"* or *"loss"* is first known to:

(1) You, if you are an individual;

(2) A partner, if you are a partnership; or

(3) An executive officer or insurance manager, if you are a corporation.

The following is added to Item **5. Transfer Of Rights Of Recovery Against Others To Us**:

We waive any right or recovery we may have against any person or organization for whom you are required in a written contract or agreement to include a waiver of transfer of rights of recovery against others to *us*, because of payments we make for injury or damage done under a contract with that person or organization.

Item **B. 2. General Conditions, Concealment, Misrepresentation Or Fraud** is amended to include the following additional paragraph:

If you unintentionally fail to disclose any hazards existing at the inception date of your policy, we will not deny coverage under this Coverage Part because of such failure.

Item **B. 7. General Conditions, Policy Period, Coverage Territory** is amended to include the following additional paragraph:

e. For short-term (30 days or less) hired autos, the coverage territory is anywhere in the world, provided that if the insured's responsibility to pay damages is determined in a "suit," that "suit" is brought in the territory described in Items **7.a. - d.**

CITY OF GLENDALE, ARIZONA
PUBLIC WORKS/ENGINEERING DEPARTMENT

CONTRACTOR'S AFFIDAVIT
REGARDING
SETTLEMENT OF CLAIMS

PROJECT 067013 - ARROWHEAD WATER RECLAMATION FACILITY MISCELLANEOUS IMPROVEMENTS - SUPPLEMENTAL CLORINATION/DECHLORINATION DISINFECTION SYSTEM

To the City of Glendale, Arizona

Gentlemen:

This is to certify that all lawful claims for materials, rental of equipment and labor used in connection with the construction of the above project, whether by subcontractor or claimant in person, have been duly discharged.

The undersigned, for the consideration of $_____ , as set out in the final pay estimate, as full and complete payment under the terms of the contract, hereby waives and relinquishes any and all further claims or right of lien under, in connection with, or as a result of the above described project. The undersigned further agrees to indemnify and save harmless the City of Glendale against any and all liens, claims of liens, suits, actions, damages, charges, costs, litigation expenses, attorneys' fees and any other and expenses whatsoever, which said City may suffer arising out of the failure of the undersigned to pay for all labor performance and materials furnished for the performance of said installation.

Signed and dated at _____ , this ____ day of _____ , 20___.

_____
Contractor

By _____

STATE OF ARIZONA)
) ss.
COUNTY OF MARICOPA)

The foregoing instrument was subscribed and sworn to before me this ___ day of _____, 20 .

_____
Notary Public

My Commission Expires: _____

SUPPLEMENTAL GENERAL CONDITIONS

1. GENERAL: By Ordinance No. 1110 New Series, the City of Glendale adopted the "Uniform Standard Specifications for Public Works Construction," which are sponsored and distributed by the Maricopa Association of Governments. Copies of these documents, with revisions, are on file in the office of the City Engineer of the City of Glendale, and are hereby made a part of these Contract Documents.

Whenever in the Uniform Standard Specifications, the words "The Contracting Agency" are used, the meaning shall be the City of Glendale.

In all cases where ASTM, AASHTO, AWWA, USAG, Federal, City of Phoenix, MAG Specifications, Maricopa County, Arizona State Highway, or other standard specifications are referred to, unless otherwise stated, revisions, supplements or addenda issued on or before the date of this contract, shall prevail. In the event of any conflict between these project specifications and the requirements of the plans, detail drawings, MAG Standard Details and Specifications, these project specifications shall prevail.

2. DEFINITIONS: The following terms, as used in or pertaining to the Contract Documents, are defined as follows:

CITY: The word "City" refers to the City of Glendale, Arizona. The official representative of said City in these proceedings shall be the City Engineer.

CONTRACTOR: The word "Contractor" means the person, firm, or corporation with whom the Contract is made by the City.

MATERIALS: The term "Materials" includes, in addition to materials incorporated in the project, equipment and other material used and/or consumed in the performance of the work.

SUBCONTRACTOR: The word "Subcontractor" includes those having a direct contract with the Contractor and those who furnish material worked to a special design according to the plans and/or specifications for this work, but does not include those who merely furnish materials not so worked.

ENGINEER: The word "Engineer" means a person, firm or corporation duly authorized by the City, to act for the City in staking out the work, inspecting materials and construction, and interpreting plans and specifications.

CONTRACT DOCUMENTS: The words "Contract Documents" mean the Notice to Contractors, Information for Bidders, "Uniform Standard Specifications for Public Works Construction," MAG General Conditions, Supplemental General Conditions, Special Provisions, Supplemental Specifications, Proposal, Contract, Payment Bond, Performance Bond, Certificates of Insurance, Plans and Addenda thereto.

3. PROPOSAL QUANTITIES: It is expressly understood and agreed by the parties hereto that the quantities of the various classes of work to be done and material to be furnished under this Contract, which have been estimated as stated in the Proposal, are only approximate and are to be used SOLELY for the purpose of comparing, on a consistent basis, the proposals offered for the work under this Contract; and the Contractor further agrees that the City will not be held responsible if any of the quantities shall be found incorrect; and the Contractor will not make any claim for damages or for loss of profits because of a difference between the quantities of the various classes of work as estimated and the work actually done. If any error, omission, or mis-statement is found to occur in the estimated quantities, the same shall not invalidate this Contract or release the Contractor from the execution and completion of the whole or any part of the work in accordance with the specifications and the plans herein mentioned, or for the prices herein agreed upon and fixed therefore, or excuse him from any of the obligations or liabilities hereunder, or entitle him to any damages or compensation except as may be provided for in this Contract.

4. WITHDRAWAL OF PROPOSALS: No proposal shall be withdrawn following the opening and reading of the bids for a period of 50 days from the date of opening without the consent of the contracting agency through the body or agent duly authorized to accept or reject the proposal.

5. LOSSES AND DAMAGES: All loss or damage arising out of the nature of the work to be done or from the action of the elements, or from any unforeseen circumstances in the prosecution of the same, or from any unusual obstructions or difficulties which may be encountered in and/or during the prosecution of the work, or from any casualty whatsoever of every description, shall be sustained and borne by the Contractor at his own cost and expense except as otherwise provided by the contract documents or the laws of the State of Arizona.

6. DUST PREVENTION: The Contractor shall take whatever steps, procedures or means required to prevent abnormal dust conditions due to his construction operations in connection with this contract. The dust control measures shall be maintained at all times during construction of the project, to the satisfaction of the Engineer, in accordance with the requirements of the "Maricopa County Health Department Air Pollution Control Regulations" which have been adopted pursuant to A.R.S. § 36-779.

The Contractor shall be required to obtain the necessary permit from the Maricopa County Air Pollution Control Bureau, 1001 N. Central Ave., Phoenix, Arizona 85004 - telephone (602) 506-6727.

7. EXCESS MATERIAL: Excess material shall be removed from the work site and wasted at a location approved by the Engineer. Broken concrete and asphalt may be delivered to the Glendale Sanitary Landfill located at 115th Avenue and Glendale Avenue. The prevailing regulations and fee schedule will not be waived for work under this project. All materials, to be disposed of at the landfill, shall be weighed and disposed of at the prevailing rate.

8. STOCKPILE OF MATERIALS: The Contractor may place or stockpile materials in the public right-of-way, if approved by the Engineer, provided they do not prevent access to adjacent properties or prevent compliance with traffic regulations.

Traffic shall not be required to travel over stockpiled materials, and proper dust control shall be maintained.

9. REFUSE COLLECTION ACCESS: At any time the project construction shall require the closure or disruption of traffic in any roadway, alley, or refuse collection easement such that normal refuse collection will be interfered with, the Contractor shall, at least 48 hours prior to causing such closure or disruption, make arrangements with the Field Operations Department in order that refuse collection service can be maintained.

10. CLEAN-UP: After all work under this contract is completed, the Contractor shall remove all loose concrete, lumber, wire, reinforcing, debris, and other materials not incorporated in the work, from the site of the work. Clean-up shall include the removal of all excess pointing mortar materials within pipes and removal of over-size rocks and boulders left after finish grading. The contractor shall provide for the legal disposal of all waste products, debris, etc., and shall make necessary arrangements for such disposal.

11. SHOP DRAWINGS: The Contractor shall provide shop drawings as may be necessary for the prosecution of the work as required by the contract documents. The Engineer shall promptly review all shop drawings. The Engineer's approval of any shop drawing shall not release the Contractor from responsibility for deviations from the contract documents. The approval of any shop drawing which substantially deviates from the requirements of the contract documents shall be evidenced by a change order.

When submitted for the Engineer's review, shop drawings shall bear the contractor's certification that he has reviewed, checked, and approved the shop drawings and that they are in conformance with the requirements of the contract documents.

Portions of the work requiring a shop drawing or sample submission shall not begin until the shop drawing or sample submission has been approved by the Engineer. A copy of each approved shop drawing and each approved sample shall be kept in good order by the Contractor at the site and shall be available to the Engineer.

12. PROTECTION OF FINISHED OR PARTIALLY FINISHED WORK: The Contractor shall properly guard and protect all finished or partially finished work, and shall be responsible for the same until the entire contract is completed and accepted, in writing, by the City. The Contractor shall turn over the entire work in full accordance with the specifications before final settlement shall be made.

13. STATUS OF EMPLOYEES: Contractor shall be responsible for assuring the legal working status of its employees and its subcontractor's employees.

14. LAWS AND REGULATIONS: This Contract shall be governed by and constructed in accordance with the laws of the State of Arizona. The Contractor shall keep himself fully informed of all existing and future City and County Ordinances and Regulations and State and Federal Laws and Occupational Safety and Health Standards (OSHA) in any manner affecting the work herein specified. He shall at all times observe and comply with said Ordinances, Regulations, or Laws.

15. PERMITS: The City has obtained certain required permits which are included in the project specifications, but it will be the duty of the Contractor to determine that all the necessary permits have been obtained. The Contractor shall, at his own expense, obtain all required permits which have not been furnished by the City. A no-fee permit will be issued for work in the City of Glendale right-of-way and easement. (Also see Paragraph 7. Dust Prevention.)

16. ELECTRIC POWER AND WATER: The Contractor shall make his own arrangements for electric power and water. Subject to the convenience of the City, he may be permitted to connect to existing facilities where available, but he shall meter and bear the cost of such power or water. Fire hydrant meters may be obtained from the City of Glendale. Installation and removal of meters should be scheduled at least forty-eight (48) hours in advance through the Public Works/Utilities Division at 930-2700. A $1,555.50 deposit is required for each meter. The cost of the water is at the prevailing rate.

17. SURVEY CONTROL POINTS AND MONUMENTS: Existing survey monuments indicated on the plans or found during construction shall be protected by the Contractor, and in the event removal is necessary, removal and replacement shall be performed by permission of the Engineer, under direct supervision of the Engineer or his authorized representative. Survey monuments shall be constructed to conform to the requirements of MAG Specifications, Section 405, and Standard Details.

18. EXISTING UTILITIES: The Contractor is hereby advised that the location of all utilities, as shown on the plans, may not be complete nor exact and the Contractor shall satisfy himself as to the exact location of the utilities by contacting Blue Stake or the utility companies before proceeding with the work. After the underground utilities are located by Blue Stake or the utility company, the contractor shall excavate in a careful and prudent manner to prevent unwillful damage to the underground utilities.

In the event the Contractor or its Subcontractor damages an existing, properly identified underground City of Glendale water or sewer line, the Contractor shall be responsible for the repairs at its expense.

The exact location of all existing underground service utilities, whether or not indicated on the plans, shall be determined by the Contractor at no expense to the City, and he shall conduct his work so as to prevent interruption of service or damage to them.

The Contractor shall protect existing utility services and be responsible for their replacement if damaged by him, or to make necessary adjustment in their location, if required, in order to complete the work for his Contract.

Utility companies and other interested parties have been provided with construction plans and the construction schedule for this project. The Contractor shall comply with MAG Specifications 105.6 to cooperate with the utility companies.

19. MAINTENANCE OF IRRIGATION FACILITIES: Where irrigation facilities interfere with construction, the Contractor shall remove and replace the affected irrigation facilities to its original condition. Final acceptance of replaced facilities will depend upon final approval of the Engineer.

20. OVERHEAD UTILITY LINES AND POLES: Contractor is advised that when work around overhead lines and poles is required on a project the Contractor is required to coordinate with Utility Companies who own and operate overhead lines and poles. The coordination may include, but not be limited to the following activities: pole bracing, de-energizing of lines, and temporary relocations. Contractor is responsible to contact the applicable Utility Company representative and discuss his proposed construction methods; in order to determine what actions the Utility Company must take and the costs related to those actions. The Contractor shall include these costs in the applicable bid items for this project.

The primary and the backup representatives for this review and cost determinations are as follows:

Arizona Public Service:	Mr. Bobby Garza	602-371-7989
Qwest:	Mr. Ron Floyd	602-630-1932
Salt River Project:	Mr. Tim Rinn	602-236-8694
Salt River Project:	Ms. Mariann Ward	602-236-6389
Cox Communications:	Mr. Ron Pint	623-328-3529
Cox Communications:	Ms. Linda Facio	623-328-3500

21. SOUTHWEST GAS FACILITIES EXPOSED DURING CONSTRUCTION: The Contractor, upon exposing a gas line during construction, shall call SOUTHWEST GAS at 602-271-4277. The Southwest Gas patrolman will respond, usually within an hour, to inspect the line. Minor cuts or abrasions to the pipe coating will be rewrapped and tracer wire will be reconnected at no cost to the City.

22. UNDERGROUND UTILITIES' BEDDING: All water, sewer, storm drain, irrigation and other conduits installed within the City of Glendale shall be bedded from bottom of excavation to one foot above the pipe with granular bedding material meeting the requirements of Section 601.4.6 of MAG Uniform Standard Specifications. The initial bedding under the pipe is required for pipe having an inside diameter of 12 inches or larger, and in all cases where rock larger than 1-1/2" is encountered in the trench bottom.

23. SEWER SERVICE LINES: The Contractor shall be responsible for locating, and protecting from damage during construction, all sewer service lines within the project which are not owned by the City. Contractor will be permitted to review the "as-builts" to assist Contractor in locating the non-City owned sewer service lines. These "as-builts" were prepared, and supplied to the City, by private developers or contractors who installed the non-City owned sewer service lines. Therefore, the City does not guarantee or warranty the accuracy of such "as-builts" and the contractor, as a condition for being allowed to review such "as-builts", hereby agrees to hold the City harmless for any and all damages or other expenses contractor may incur as a result of any inaccuracies or incorrect information in these "as-builts".

24. RIGHTS-OF-WAY: The City will provide rights-of-way and easements for all work specified in this Contract, and the Contractor shall not enter or occupy with man, tools, equipment or materials any private ground outside the property of the City of Glendale, Maricopa County, Arizona, without the consent of the owner of such property.

25. SUBCONTRACTS: Subcontracts shall be in accordance with, and the Contractor shall be bound by, the following provisions:

All subcontracts shall be subject to the approval of the City.

All subcontracts shall be in writing and shall provide that all work to be performed thereunder shall be performed in accordance with the terms of the Contract.

Certified copies of any and all subcontracts shall be furnished to the City Engineering Department; however, prices may be omitted.

Subcontracts shall conform to the regulations governing employment of labor.

The subcontracting of any part of the work will in no way relieve the Contractor of his responsibility under the Contract.

26. PRE-CONSTRUCTION CONFERENCE: After completion of the Contract Documents, to include bonds, insurance and signatures, and prior to the commencement of any work on the project, the Engineer will schedule a Pre-Construction Conference. This will be held at the City of Glendale, 5850 West Glendale Avenue, Glendale, Arizona.

The purpose of this Conference is to establish a working relationship between the Contractor, Utility Companies, and the Engineer. The agenda will include critical elements of the construction schedule, procedures for handling shop drawings and other submittals, cost breakdown of major lump sum items, payment application and processing, coordination with the involved utility companies, emergency telephone numbers for all representatives involved in the course of construction, and establishment of the Notice to Proceed date.

Minimum attendance by the Contractor shall be a responsible official of the company/corporation, who is authorized to execute and sign documents on behalf of the company/corporation.

27. OVERTIME:

Regular Work Hours: The work required to be performed by the Plans and Specifications for the Project shall be performed only during regular working hours, unless the City has authorized overtime work in accordance with the procedures set forth below. Regular working hours shall be defined as one 8-1/2 hour shift per day, Monday through Friday, or, upon prior approval of the City, one 10-1/2 hour shift per day on a compressed four day work week during Monday through Friday. Regular working hours shall not include Saturdays, Sundays or City recognized legal holidays.

Authorization and Costs: If the Contractor desires to schedule work for times other than regular work hours (overtime), the Contractor shall make a written request to the City at least two business days prior to the scheduled overtime. The City reserves the right to deny the request to work overtime based on the best interest and needs of the City. If an overtime request is denied, the City may, at its sole discretion, extend the contract time at no additional costs to the City.

In the event the Contractor does perform work overtime, with or without the prior approval of the City, the Contractor shall be responsible to the City for all additional costs that may be incurred by the City as a result of the Contractor's overtime work, including costs for engineering, inspections, testing, surveying and construction administration, all in accordance with MAG Section 108.5. However, the Contractor shall not be responsible for City's costs incurred as a result of overtime work requested by the City or overtime work resulting from an emergency which is not the responsibility of the Contractor or its employees, subcontractors or suppliers. The City's cost will be billed directly to the Contractor or may, at the City's option, be deducted from monies due the Contractor.

28. CONTRACTOR'S CONSTRUCTION SCHEDULE: Concurrently, with the execution of the contract and prior to the pre-construction conference, the Contractor shall submit a preliminary schedule for the Engineer's acceptance. The schedule shall be in sufficient detail to allow the Engineer to determine if the proposed schedule will conform to an approved program of construction operations, as determined by the contracting agency. Within ten calendar days after the preliminary schedule, described above, has been approved by the Engineer, the Contractor shall submit a progress schedule, utilizing the critical path method scheduling technique, showing the order in which he proposes to carry out the work, the dates on which he will start each phase of the work, and the contemplated date

for completion of each phase. The Contractor shall not be permitted to commence construction until the schedule complying with this paragraph has been submitted to the City. The Contractor will not be granted any extension to the contract time or compensation for any damages as a result of the City's refusal to allow Contractor to commence construction until the critical path method progress schedule has been submitted and approved by the Engineer.

The critical path method (CPM) scheduling technique requires a breakdown of the entire work into individual tasks and an analysis of the number of days required to perform each task. The schedule submitted to the City should highlight and identify the critical path for the project. After the work is in progress, the Contractor shall submit supplementary progress schedules, using the critical path method technique, of the progress to date and projection for completion. The supplementary progress schedules shall be submitted with each pay request in accordance with the paragraph, "Payments to Contractors," of these Supplemental General Conditions. The progress schedules shall be subject to the approval of the Engineer. In the event the Contractor fails to submit a supplementary progress schedule acceptable to the Engineer, the City may withhold further progress payments to the Contractor until the Contractor submits an acceptable supplementary progress schedule, which is approved by the Engineer, to the City. Schedule changes requiring an increase in the City's engineering personnel on the project shall not be put into effect until the Engineer has approved such increase and made arrangements for the required additional personnel.

29. CHARACTER OF WORKMEN: None but skilled foremen and workmen shall be employed on work requiring special qualifications. When required by the Engineer, the Contractor shall discharge any person who is, in the opinion of the Engineer, disorderly, dangerous, insubordinate, incompetent, or otherwise objectionable. The Contractor shall keep the City harmless from damages or claims for compensation that may occur in the enforcement of this section of the specifications.

30. HINDRANCES AND DELAYS: Except as otherwise provided herein, no charge shall be made by the Contractor for hindrances or delays from any cause during the progress of the work embraced in this Contract; but such delays, if due to no fault or neglect of the Contractor, shall entitle the Contractor to an extension of time allowed for completing the work, sufficient to compensate for the delay, the amount of the delay to be determined by the Engineer, provided the Contractor shall give said Engineer immediate notice in writing of the cause of such delay.

30.1 Delay: In the event of a delay for which the City is solely responsible, which is unreasonable under the circumstances and which was not within the contemplation of City and Contractor at the time this Contract is executed, City and Contractor shall negotiate, in good faith, a payment by the City to Contractor for the expenses incurred by Contractor as a result of such delay, in accordance with the City of Glendale Engineering Department's POLICY STATEMENT FOR CALCULATING DELAYS AND DAMAGES. This provision shall not be construed to void any provision in the contract which requires notice of delay or provides for liquidated damages. However, if the delay is the result of any act or neglect of a third party, including the architect, engineer or other contractor employed by the City, or by labor disputes, fire, unusual delay in transportation, adverse weather conditions not reasonably foreseeable, unavoidable casualties, or any causes beyond the Contractor's control, the Contractor shall not be entitled to any payments or compensation for expenses incurred as a result of such delay, but the Contract Time shall be extended by Change Order for such reasonable time as the Engineer may determine. No extension or compensation will be granted for any delay which is the result, wholly or partially, of any act or neglect of Contractor or any Subcontractor hired by Contractor.

31. LIQUIDATED DAMAGES:

31.1 Should the contractor fail to substantially complete the work under this contract within the time for completion stated in the paragraph "Time of Completion," in the Information for Bidders, then the contractor shall pay the City of Glendale, Arizona, liquidated damages, pursuant to the provisions of Section 108.9, Standard Specifications for Public Works Construction, Maricopa Association of Governments, until the work is substantially complete.

31.2 Should the contractor fail to fully and finally complete the work under this contract within the

time for completion set forth in the paragraph "Time of Completion," in the Information for Bidders, even though the contractor has achieved substantial completion of the work within such time, then the contractor shall pay the City of Glendale, liquidated damages (pursuant to the provisions of Section 108.9, Standard Specifications for Public Works Construction, Maricopa Association of Governments), in an amount equal to 100% of the applicable liquidated damage rate set forth in MAG Section 108.9 for each and every calendar day of delay until the work is fully and finally complete and accepted.

31.3 The date of substantial completion shall be the date when the work is sufficiently complete, in accordance with the contract documents, so the owner can fully occupy and utilize the work or designated portion thereof for the use for which it is intended, with all the project's parts and systems operable as required by the contract documents and all the work is complete, accessible, operable, and usable by the owner for its intended purpose(s), and all parts, systems and sitework are 100% complete and cleaned for the owner's use. Only incidental corrective work and final cleaning (if required), beyond cleaning needed for the owner's full use, may remain for final completion.

31.4 Full and final completion shall be that date when all work under the project, including incidental corrective work under punch list and final cleaning, has been completed and the entire project is accepted by the owner.

32. PAYMENTS TO CONTRACTOR: The measurements of quantities and the payments to the Contractor shall be in accordance with MAG Uniform Standard Specifications for Public Works Construction, Part 100 - General Conditions, Section 109 - Measurements and Payments.

Payments will be made on the basis of itemized, monthly statements prepared by the City and signed by the Contractor. The Contractor shall submit an itemized, duly certified and approved estimate for work completed through the last day of the preceding month in accordance with MAG Specifications, as amended by these Supplemental General Conditions. Upon approval of the pay estimate, the City will mail the check directly to the Contractor.

The pay estimate shall be accompanied by an updated progress schedule as required by these Supplemental General Conditions and a cash flow report when required by the Special Provisions. Approval of progress payments shall be conditional upon submittal of progress schedules and cash flow reports, when required, which are acceptable to the Engineer.

Upon 100% completion and acceptance of the project, and with the request for final payment, the Contractor shall complete and submit the "Contractor's Affidavit Regarding Settlement of Claims" form which is included in these specifications. Before final payment and release of retention, Contractor must arrange for its Surety to provide the City with a fully executed AIA Consent of Surety form. To avoid delays in the final payment, the Surety may send the Consent of Surety directly to the City via fax at (623) 915-2689, and mail the original to the City of Glendale Engineering Department, 5850 West Glendale Avenue, Glendale, Arizona 85301. Should any ambiguity arise between the Contract and these Conditions, the provisions of the Contract shall prevail.

END OF SUPPLEMENTAL GENERAL CONDITIONS

SPECIAL PROVISIONS

1. SCOPE OF WORK:

A. The work consists of construction of supplemental chlorination/dechlorination systems to include a new sodium bisulfite facility, additional sodium hypochlorite feed pumps, sample pumps, chlorine residual analyzers, associated yard piping, and electrical/instrumentation equipment.

B. Comply with codes, ordinances, regulations, orders, and other legal requirements of public authorities having bearing on the performance of the Work.

C. Location of the project: The Work is located at Arrowhead Ranch Water Reclamation Facility (ARWRF), 8180 Union Hills Drive, Glendale, Arizona 85310.

2. ORDER OF PRECEDENCE

In the event a conflict exists between Contract Documents, the order of precedence listed in descending order shall be as follows:

- Change Orders.
- Addenda.
- Special Provisions.
- Project Plans and Specifications.
- Supplemental General Conditions
- MAG Uniform Standard Specifications.
- MAG Standard Details.

3. DEFINITIONS:

A. Section: Reference to a Section on the plans or in these Specifications shall mean a Section of the Uniform Standard Specifications for Public Works Construction, sponsored and distributed by Maricopa Association of Governments (MAG), latest revision. The provisions of MAG Uniform Standard Specifications and Details for Public Works Construction, which are not altered or modified by the drawings or by these Special Provisions or by any subsequently issued Addendum, shall apply to the contract even though the Contractor's attention is not specifically drawn to such provisions.

B. Standard Detail: Reference to a MAG Standard Detail (MAG S.D.) on the plans or in these specifications shall mean a standard detail drawing in the latest revision of the Uniform Standard Specifications for Public Works Construction, sponsored and distributed by Maricopa Association of Governments. City of Glendale Standard Detail (C.O.G. S.D.) shall mean a standard detail drawing in the City of Glendale's Engineering Design and Construction Standards, latest revision. City of Phoenix Standard Detail (C.O.P. S.D.) shall mean a standard detail drawing in the Phoenix Supplemental Standard Details for Public Works Construction, latest revision.

C. 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.

D. 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.
Work Change Directive: A written statement to CONTRACTOR issued on or after the effective date of the Agreement and signed by OWNER and recommended by ENGINEER ordering an addition, deletion, or revision in the Work, or responding to differing or unforeseen subsurface or physical

conditions under which the Work is to be performed or to emergencies. A Work Change Directive will not change the Contract Price or the Contract Times but is evidence that the parties expect that the change ordered or documented by a Work Change Directive will be incorporated in a subsequently issued Change Order following negotiations by the parties as to its effect, if any, on the Contract Price or Contract Times.

4. CHANGE ORDERS AND FIELD ORDERS

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:
- A field order;
- ENGINEER's approval of a shop drawing or sample; or
- ENGINEER's written interpretation or clarification.

5. CONSTRUCTION SURVEYING AND LAYOUT: The work under this item shall consist of furnishing all materials, personnel, equipment, and traffic control necessary to perform all surveying, staking, and verification of the accuracy of all control points per the plans and as directed by the Engineer. Included in this work shall be all calculations required for the satisfactory completion of the project in conformance with the plans and these Special Provisions. The work shall be done under the direction of a registered professional engineer or a registered land surveyor employed by the Contractor. The crew chief shall be NICET Certified Level III or a registered land surveyor. The Contractor shall furnish all equipment, materials and other devices necessary for establishing, checking, marking and maintaining points, lines, grades and layouts.

Throughout the work, the Contractor shall set all stakes including, but not limited to; centerline stakes; offset stakes; reference point stakes; slope stakes; pavement lines, curb lines and grade stakes at intervals not greater than 25 feet; stakes for sewers, roadway drainage, pipe, under drains, clearing, paved gutter, fence, right of way markers, and survey monuments; blue tops of subgrade, subbase and base courses at intervals not greater than 50 feet; permanent as-built elevation marks; and all other horizontal or vertical controls necessary for complete and accurate layout and construction of the work. Stakes for horizontal and vertical curves shall be set at intervals appropriate for the length of curve. The coordinates of any new control points established by the Contractor during the course of the work shall be given to the Engineer within five working days of control point establishment.

Field notes shall be kept in standard field notebooks furnished by the Contractor. Field notes shall be kept in a clear, orderly and neat manner consistent with standard surveying practices. The standard field notebooks or copies of, shall be made available to the Engineer upon request at any time during the prosecution of the work.

When utility adjustments are a part of the contract, the Contractor shall perform all layout work and set all control points, stakes and references necessary for carrying out all such adjustments.

The Contractor shall cross-section all fill areas for monthly, quantity estimates and as directed by the Engineer. The Engineer may verify the accuracy of same. The Engineer shall check all measurements that involve determination of final quantities.

Any errors, omissions or discrepancies in the project plans shall be immediately brought to the attention of the Engineer. The Contractor shall promptly notify the Engineer in writing, explaining the problem in detail. The Engineer will advise the Contractor within three working days of any

corrective actions deemed necessary. No changes in the project plans will be allowed without the approval of the Engineer.

The Contractor shall be compensated for additional work associated with survey and layout when:

A. The project plans do not provide sufficient information and new calculations must be performed.

B. The Contractor performs survey work based on erroneous plan information, which results in the duplication of work.

C. Changes by the Engineer to the plan information for which the Contractor has already performed the work and results in the duplication of such work.

The Contractor shall not be due compensation for any survey work when:

A. Information provided on the plans is sufficiently complete to allow any additional information necessary for the complete layout of the work to be routinely calculated.

B. The Contractor fails to inform the Engineer of discovered plan errors before the performance of any extra survey work.

C. Work is included in any other pay item.

The Contractor shall inform the Engineer in a timely manner of any omissions, ambiguities, or errors which the Contractor feels may result in extra calculations or survey work, so as not to delay the project or create any unnecessary calculations.

All additional survey work shall be documented by the Contractor and verified by the Engineer before compensation may be granted. Documentation shall consist of a detailed diary specifically addressing the work involved in the alleged problem area. The Contractor may be required to provide calculations, charts, graphs, drawings, or any other physical evidence, which will verify additional work.

The Contractor shall be responsible for verifying curb and gutter grades before placement of concrete using a steel straightedge, string line or other method approved by the Engineer. The field verification shall be performed in the presence of the Engineer or designated representative.

The Engineer reserves the right to make inspections and random checks of the staking and layout. Inspection or acceptance of all or any part of the Contractor's staking and layout by the Engineer does not relieve the Contractor of full responsibility to secure the proper dimensions, grades and elevations of the work.

If, in the Engineer's opinion, the work is not being performed in a manner that will assure proper controls and accuracy, the Engineer will order any or all of the staking and layout work redone at no additional cost to the City. If any portion of the Contractor's staking and layout work is ordered redone and requires additional rechecking by the Engineer, the City shall be reimbursed for all costs for such additional checking. The amount of such costs will be deducted from the Contractor's monthly estimate.

The Contractor shall provide final "as-constructed" field surveying, including both vertical and horizontal data based on the finished work. The Contractor shall also furnish final Record Drawings for

all improvements. The Record Drawings shall be prepared by a Registered Land Surveyor and submitted to the Owner for approval prior to final acceptance of the project. The Record Drawings shall be prepared on a set of reproducible copies of the construction plans. The completed drawings shall be signed and sealed by the Registered Land Surveyor responsible for obtaining the As-built information and preparing the Record Drawings.

All survey field books and documentation shall be available for inspection by the Engineer.

Payment for this item will be made at the contract lump sum price fully complete for **M1058000 CONSTRUCTION SURVEYING AND LAYOUT**.

6. SUSPENSION OF WORK: The Engineer reserves the right to suspend the work wholly or in part if deemed necessary for the best interest of the City. This suspension will be without compensation to the Contractor, other than to adjust the contract time in accordance with MAG Section 108.

7. COMPLIANCE WITH MANUFACTURER'S INSTRUCTIONS: In all instances wherein the item and/or specifications require installation or construction in accordance with either manufacturer's or supplier's recommendations and/or instructions, said recommendations and/or instructions shall be submitted with the applicable portions clearly marked for approval prior to the commencement of work on that item or portion of the contract.

8. TRAFFIC REGULATIONS:

8.1 All traffic affected by this construction shall be regulated in accordance with the City of Phoenix "Traffic Barricade Manual," and these Special Provisions. The following traffic restrictions are minimum requirements throughout the construction period:

8.1.1 All traffic restrictions listed herein are to supplement the City of Phoenix "Traffic Barricade Manual," and are not intended to delete any part of the manual. All reference in the "Traffic Barricade Manual" to "arterial" and/or "collector" streets shall mean "arterial and/or major arterial" streets and are referred to as "major" streets in the following sections.

8.1.2 A minimum of two travel lanes (one for each direction) shall be maintained open to traffic at all times on all major streets. All work that enters or crosses a major street must be done at times other than 6:00 a.m. to 8:30 a.m., and 4:00 p.m. to 7:00 p.m.

8.1.3 A travel lane shall be defined as ten (10) feet of roadway with a safe motor vehicle operating speed of twenty-five (25) miles per hour.

8.1.4 A travel lane will not be considered as satisfactorily open to traffic until it has been graded reasonably smooth and is paved with a minimum of two (2) inches of asphalt. This shall be considered temporary pavement and shall be removed completely before proceeding with final surfacing.

8.1.5 The Contractor shall provide and maintain all necessary traffic controls, and must provide flashing arrow boards to protect and guide traffic for all work in the construction area.

8.1.6 Intersection area shall be defined as all of the area within the right-of-way of intersecting streets, plus two-hundred fifty (250) feet beyond the center of the intersected streets on all legs of the intersection.

8.1.7 The Contractor shall maintain all existing traffic signs erect, clean and in full view of the intended traffic at all times. Street name signs at major street intersections shall be maintained erect at all times. If any signs interfere with construction, the Contractor shall

notify the Inspector at least 48 hours in advance for City forces to remove said signs. The Contractor shall be responsible for having all temporary traffic control signs installed and maintained during construction. The Transportation Department will re-set all traffic and street name signs to permanent locations when notified by the Engineer that construction is complete.

8.1.8 Local access to all properties on the subject project shall be maintained at all possible times in the form of a safe and reasonable direct route to at least one of the above defined major streets. Whenever local access cannot be maintained, the Contractor shall notify the affected property owner or user and the Engineer at least twenty-four (24) hours in advance.

8.1.9 The Contractor shall be required to provide a uniformed off-duty City of Glendale police officer to assist with traffic control whenever traffic in any one direction is restricted to one lane at a signalized major intersection or at other locations if it should become necessary in the opinion of the Engineer. During construction activities that do not restrict a major signalized intersection, police officer assisted traffic control is not required. If the Contractor chooses to use a police officer at other locations during peak traffic hours or to assist with his other traffic control operations, the cost shall be included in the lump sum for "Traffic Control" and not paid out of the hours allowed for "Off Duty Glendale Police Officer." All requests for off-duty officers will be made through the Glendale Police Department, Off-Duty Work Administrator. The Contractor must provide evidence of workmen's compensation coverage before any officer will be permitted to work.

Measurement for payment of the uniformed off-duty Glendale police officer hours will be made by the actual number of man-hours used for traffic control at signalized major intersections or as approved by the Engineer. Because the quantity of hours is dependent on the Contractors schedule of activities, the unit price bid for this item will be administered as a contingency bid item and any adjustment in hours will not be subject to the 20 percent limitation.

Payment for the off-duty Glendale police officer will be made at the contract unit price bid per hour for OFF DUTY GLENDALE POLICE OFFICER and shall include the net hourly rate of $35.00 per police officer with a three (3) hour minimum. The net hourly rate shall be increased to include withholding for Federal, State, FICA, Medicare, Workmen's Compensation insurance and any payroll administrative costs.

8.1.10 The Contractor shall prepare a traffic control plan for the project and submit it to the City Transportation Director for review and approval at least seven (7) working days before the pre-construction conference. The traffic control plan shall include flashing arrow boards, barricades and signs, and shall address how local access to adjacent properties will be handled in accordance with the specifications herein. Any changes to the traffic control plan during construction shall be submitted to the City Transportation Director for approval at least seventy-two (72) hours before implementation.

Payment for this item shall be made at the contract lump sum price for TRAFFIC CONTROL.

8.1.11 It is the City's desire to maintain one lane of traffic in each direction on minor streets whenever possible. Should it become imperative for the Contractor to close off a portion of any minor street or reduce the travel way to a single lane, he must obtain approval from the City Transportation Director twenty-four (24) hours prior to implementing a traffic control change. He must provide all the necessary signs to detour traffic and/or flagmen to control traffic for a single lane. The maximum amount of time that the street may be closed is from 9:00 a.m. until 4:00 p.m.

9. ENERGIZED AERIAL ELECTRICAL POWER LINES: The utility company maintains energized aerial electrical power lines in the immediate vicinity of this project. Do not consider these

lines to be insulated. Construction personnel working in proximity to these lines are exposed to an extreme hazard from electrical shock. Contractors, their employees, and all other construction personnel working on this project must be warned of the danger and instructed to take adequate protective measures, including maintaining a minimum ten (10) feet clearance between the lines and all construction equipment and personnel. (See: OSHA Standard 1926.550(a)15.) As an additional safety precaution, Contractors should also be instructed to call the utility company to arrange, if possible, to have these lines de-energized or relocated when the work reaches their immediate vicinity. The cost of such temporary arrangements would be borne by the Contractor. The utility company can often respond to such requests if two days advance notice is given, but some situations may require up to sixty (60) days lead time for relocation or other arrangements.

10. CONCRETE GUTTER WATER TESTING: The MAG Uniform Standard Specifications, Section 340.3, CONSTRUCTION METHODS, shall be modified as follows: The 1/2 inch referenced in Paragraph 16 beginning, "When required by the Engineer, gutter having a slope of 0.8 foot...," shall be changed to 1/4 inch.

11. RECORD DRAWINGS: The Contractor shall maintain one set of contract drawings with all changes, deviations, additions and deletions clearly marked thereon. Upon completion of the work, this set of drawings, shall be marked "RECORD DRAWINGS," dated, and delivered to the Engineer prior to approval of the Contractor's final payment request.

12. SOILS REPORT: The boring logs and soils report for this project are available for review at the City Engineering Office upon request. The boring logs and soils report are provided only as a courtesy. The logs and soils reports are not incorporated into, or part of, the contract and the City of Glendale makes no warranties, express or implied, as to the accuracy of the information contained therein. The Contractor should not rely on the information contained therein and should perform its own investigation as to the subsurface conditions of the project. The logs and soils reports are not intended, nor should they be relied upon by the Contractor as, a representation of the true soil conditions of the project. If there is a conflict between this provision and any other provision of the contract documents, this provision will prevail. The Contractor will accomplish the project under whatever condition he finds at the contract price.

13. CASH FLOW REPORT: The Contractor shall prepare a Cash Flow Report for projected monthly project cash flow on a City provided form and submit it for approval prior to issuance of the Notice to Proceed. The accumulation of monthly pay estimate costs shall be plotted versus time in accordance with the proposed construction schedule. After approval, the Contractor shall submit an updated Cash Flow Report prior to the receipt of each Progress Payment. Each updated Cash Flow Report shall reflect the Contractor's actual monthly payment versus the actual elapsed contract time.

At the City's request, if the projected quarterly project cash flow varies by more than ten percent of the total contract price, the Contractor shall prepare a revised Cash Flow Report. Each revised Cash Flow Report is subject to approval by the City prior to issuance of the progress payment.

Revisions to the report resulting from Contractor initiated delays or work schedule changes shall be at no cost to the City. Any revisions required by City initiated delays or changes to the work shall be paid as an integral part of the approved Change Order.

14. CONSTRUCTION SIGN: The project type to be indicated on the sign shall be 067013 - ARROWHEAD WATER RECLAMATION FACILITY MISCELLANEOUS IMPROVEMENTS - SUPPLEMENTAL CLORINATION/DECHLORINATION DISINFECTION SYSTEM . See "Construction Sign Detail."

15. ALLOWANCE FOR CONSTRUCTION CONTINGENCIES: Bid schedule includes a lump sum contingency allowance. This allowance is at all times the property of the City and is for the sole purpose of reimbursing Contractor for any unforeseen work not apparent at the time of bidding or additional work requested by the CITY OF GLENDALE.

No work anticipated for reimbursement under this Bid Item shall be initiated by Contractor until Contractor, City of Glendale Representative and City of Glendale agree on the scope and cost to

perform the additional work. The Contractor shall prepare and submit to City of Glendale Representative a cost itemization and summary for the additional work. City of Glendale Representative and City of Glendale shall review and approve prior to Contractor proceeding with any additional work. Any portion of the stated sum not expended remains the property of the City of Glendale.

Work under this section shall consist of any additional work identified by the owner and contractor due to construction activity. All work under this item shall be itemized as per MAG requirements and deducted from the set amount of $50,000. All work under this section shall include but is not limited to all necessary materials, tools, layout, survey and labor required to complete each task.

Measurement and payment for this item shall be made on an individual basis per task and as described above. Limit for this item is set at $50,000 on the bid form, under line item ALLOWANCE FOR CONSTRUCTION CONTINGENCY.

16. CONSTRUCTION MEANS AND METHODS AND SAFETY

A. CONTRACTOR shall be solely responsible for the means, methods, techniques, sequences, and procedures of construction.

B. CONTRACTOR shall be solely responsible for initiating, maintaining and supervising all safety precautions and programs in connection with the Work

17. CONSTRUCTION AIDS

A. Provide railings, kick plates, enclosures, safety devices, and controls required by Laws and Regulations and as required for adequate protection of life and property.
B. Use construction hoists, elevators, scaffolds, stages, shoring, and similar temporary facilities of ample size and capacity to adequately support and move loads.
C. Design temporary supports with adequate safety factor to assure adequate load bearing capability.
   1. When requested, submit design calculations by professional registered engineer prior to application of loads.
   2. Submitted design calculations are for information and record purposes only.
D. Accident prevention:
   1. Exercise precautions throughout construction for protection of persons and property.
   2. Observe safety provisions of applicable Laws and Regulations.
   3. Guard machinery and equipment, and eliminate other hazards.
   4. Make reports required by authorities having jurisdiction, and permit safety inspections of the Work.
   5. Before commencing construction Work, take necessary action to comply with provisions for safety and accident prevention.
E. Barricades:
   1. Place barriers at ends of excavations and along excavations to warn pedestrian and vehicular traffic of excavations.
   2. Provide barriers with flashing lights after dark.
   3. Keep barriers in place until excavations are entirely backfilled and compacted.
   4. Barricade excavations to prevent persons from entering excavated areas in streets, roadways, parking lots, treatment plants, or other public or private areas.
F. Warning devices and barricades:
   1. Adequately identify and guard hazardous areas and conditions by visual warning devices and, where necessary, physical barriers.
   2. Devices shall conform to minimum requirements of OSHA and State agency which administers OSHA regulations where Project is located.
G. Hazards in protected areas:
   1. Mark or guard excavations in areas from which public is excluded, in manner appropriate for hazard.
H. Above grade protection:

1. On multi-level structures, provide safety protection that meets requirements of OSHA and State agency which administers OSHA regulations where Project is located.

I. Protect existing structures, trees, shrubs, and other items to be preserved on Project site from injury, damage or destruction by vehicles, equipment, worker or other agents with substantial barricades or other devices commensurate with hazards.

18. SECURITY

A. Make adequate provision for protection of the Work area against fire, theft, and vandalism, and for protection of public against exposure to injury.

B. Description:
1. CONTRACTOR shall safely guard all Work, materials, equipment, and property from loss, theft, damage, and vandalism.
2. CONTRACTOR's duty to safely guard property shall include the OWNER's property and other private property from injury or loss in connection with the performance of the Contract.
3. CONTRACTOR shall make no claim against the OWNER for damage resulting from trespass.
4. All costs for security as specified in this Section shall be borne by the CONTRACTOR.

C. CONTRACTOR's access to the Site:
1. Access to the site for CONTRACTOR's employees, material, tools, and equipment shall be directly through the main Arrowhead Ranch Water Reclamation Facility front gate. For work inside the existing plant boundary, coordinate with the OWNER to obtain access requirements and protocols prior to initiating work.
2. The CONTRACTOR shall ensure that each of his employees, representatives, material-men, suppliers, and other acting for the CONTRACTOR shall be subject to the following regulations:
   a. Names of all CONTRACTOR's employees and subcontractors, suppliers, and manufacturers' employees requiring entrance to the site shall be listed on a security roster maintained by plant operations staff.
   b. At all times CONTRACTOR's employees and subcontractors, suppliers, and manufacturers' employees entering the site may be required to show a photo identification (ID) to plant security/personnel before entering. Acceptable IDs are valid drivers license issued in the United States, state issued ID, employer issued ID, military ID, and drivers license issued outside the United States and a work permit. Names on the ID must match the names listed on the security roster. In the event a construction "day labor" does not have the required photo ID, the Construction Superintendent for the CONTRACTOR may take responsibility for the person, including supervision of the laborer on the site at all times. Signatures of all persons entering the site will be required.
   c. The CONTRACTOR shall notify plant security/personnel at the plant entrance of all scheduled deliveries to the site. Notification shall be provided 2 to 3 hours prior to delivery and shall include: expected time of arrival, the security seal number or listing of merchandise to be delivered, type of chemicals being delivered (if applicable), a fax copy of the driver's name, picture ID, and delivery vehicle license plate number.
   d. CONTRACTOR's subcontractors, suppliers, and manufacturers' employees shall not park anywhere other than the CONTRACTOR Employee's Parking Area. The area shall be designated by the ENGINEER, as indicated on the Drawings. The CONTRACTOR shall prepare and maintain this area, as required.
   e. All work vehicles, including those belonging to CONTRACTOR, his employees and subcontractors, his material-men and suppliers entering the plant site shall conform to all security and safety regulations in force at the site, and in addition, must display a vehicle tag in the windshield while on the plant site. The vehicle tag shall be 3 inches by 5 inches permanently mounted to the windshield (lower left-hand corner). The vehicle tag shall be green and identify the CONTRACTOR, subcontractor, etc.
   f. Personal vehicles shall not be allowed outside the employee parking area (as indicated on the Drawings).
   g. Delivery vehicles shall access the project site through the off-site construction area

as used by the CONTRACTOR.

h. Access to the site from any other entrance is strictly prohibited. Violators shall be banned from the site.

19 CLOSEOUT DOCUMENTS

A. Submit following Closeout Submittals upon completion of the Work and at least 7 days prior to submitting Application for Final Payment:

1. Evidence of compliance with requirements of governing authorities.
2. Project Record Documents.
3. Operation and Maintenance Manuals.
4. Warranties and Bonds.
5. Keys and Keying Schedule.
6. Evidence of Payment and Release of Liens as outlined in Conditions of the Contract.
7. Release of claims.
8. Survey Record Documents.
9. Certificate of Final Completion.

END OF SPECIAL PROVISIONS

Project Life Cycle
Cash Flow Schedule

Project No.: _____ Date: _____

Project Name: _____

Company Name:

Project Start Date: _____ Project Completion Date _____

Original ☐ Updated ☐ Revised ☐

		Estimated		Actual	
Qtr.	Fiscal Yr.	Amount	Accum.	Amount	Accum.
1st	07/06 - 09/06	$ -			
2nd	10/06 - 12/06				
3rd	01/07 - 03-07				
4th	04/07 - 06/07				
1st	07/07 - 09/07			$ -	$ -
2nd	10/07 - 12/07				
3rd	01/08 - 03/08				
4th	04/08 - 06/08				
1st	07/08 - 09/08		$ -	$ -	$ -
2nd	10/08 - 12/08				
3rd	01/09 - 03/09				
4th	04/09 - 06/09				
1st	07/09 - 09/09	$ -	$ -	$ -	$ -
2nd	10/09 - 12/09				
3rd	01/10 - 03/10				
4th	04/10 - 06/10				
1st	07/10 - 09/10				
2nd	10/10 - 12/10	$ -	$ -	$ -	$ -
3rd	01/11 - 03/11				
4th	04/11- 06/11				
	Totals	$ -		$ -	

* COG's fiscal year is July 1, (current year) through June 30, (following year)

For Engineering Use Only:

Account No: _____ PO No. _____

Design-ConstAdm.

CONSTRUCTION SIGN DETAIL

CONSTRUCTION SIGNS ARE TO BE IN PLACE BEFORE PHYSICAL CONSTRUCTION BEGINS

SIGNS SHALL BE MADE OF 3/4" AC EXTERIOR PLYWOOD OR OTHER MATERIAL APPROVED BY THE ENGINEER

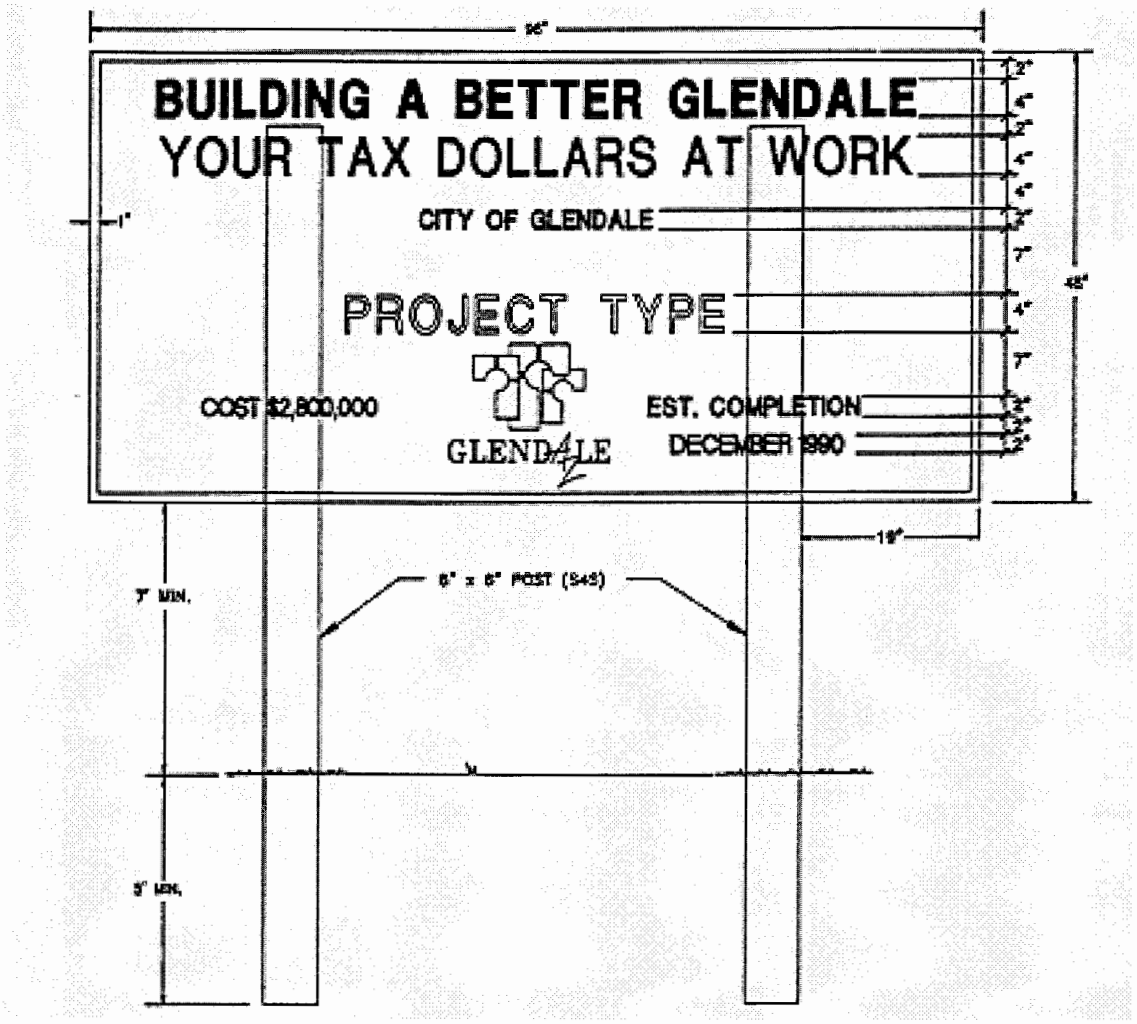
BACKGROUND TO BE PAINTED WHITE WITH STENCIL BLACK LETTERS, NUMERALS AND BORDER.

POSTS SHALL BE PAINTED WHITE. ALL MOUNTING HARDWARE TO BE RUST PROOF MATERIAL

SIGNS SHALL BE SO PLACED THAT THEY WILL NOT OBSCURE OR DETRACT FROM OTHER SIGNING.

CONTRACTOR TO FILL IN THE PROJECT TYPE, COMPLETION DATE, AND COST AS DIRECTED.

THE 12"X13" TWO COLOR GLENDALE LOGO IS AVAILABLE BY CONTACTING THE CITY OF GLENDALE ENGINEERING DEPT. COST $16.00



10/22/96

ARROWHEAD RANCH WATER RECLAMATION FACILITY - MISCELLANEOUS IMPROVEMENTS PROJECT

SUPPLEMENTAL CHLORINATION/DECHLORINATION DISINFECTION SYSTEM

TECHNICAL SPECIFICATIONS

BID SET

Volume 1 of 2

APRIL 2011

The undersigned has approved this document for and on behalf of Carollo Engineers, P.C.

Vice President

EXPIRES 3/31/2014

carollo

4600 East Washington, Suite 500 • Phoenix, Arizona 85034 • P. 602.263.9500 • F. 602.265.1422

ARROWHEAD RANCH WATER RECLAMATION FACILITY - MISCELLANEOUS IMPROVEMENTS PROJECT

SUPPLEMENTAL CHLORINATION/DECHLORINATION DISINFECTION SYSTEM

TECHNICAL SPECIFICATIONS

BID SET

Volume 1 of 2

APRIL 2011

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ARROWHEAD RANCH WATER RECLAMATION FACILITY - MISCELLANEOUS IMPROVEMENTS PROJECT

SUPPLEMENTAL CHLORINATION/DECHLORINATION DISINFECTION SYSTEM

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EXPIRES 3/31/2014

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SECTION 01329

SAFETY PLAN

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Development and maintenance of a Construction Safety Plan.

1.02 REFERENCES

A. OSHA.

1.03 CONSTRUCTION SAFETY PLAN

A. Detail the methods and procedures to comply with federal, and local health and safety laws, rules and requirements for the duration of the Contract Times. Include the following:
   1. Identification of the certified or licensed safety consultant who will prepare, initiate, maintain and supervise safety programs, and procedures.
   2. Procedures for providing workers with an awareness of safety and health hazards expected to be encountered in the course of construction.
   3. Safety equipment appropriate to the safety and health hazards expected to be encountered during construction. Include warning devices, barricades, safety equipment in public right-of-way and protected areas, and safety equipment used in multi-level structures.
   4. Methods for minimizing employees' exposure to safety and health hazards expected during construction.
   5. Procedures for reporting safety or health hazards.
   6. Procedures to follow to correct a recognized safety and health hazard.
   7. Procedures for investigation of accidents, injuries, illnesses and unusual events that have occurred at the construction site.
   8. Periodic and scheduled inspections of general work areas and specific work stations.
   9. Training for employees and workers at the jobsite.
   10. Methods of communication of safe working conditions, work practices and required personal protection equipment.

B. Assume responsibility for every aspect of health and safety on the jobsite, including the health and safety of subcontractors, suppliers, and other persons on the jobsite:
   1. Forward available information and reports to the Safety Consultant who shall make the necessary recommendations concerning worker health and safety at the jobsite.
   2. Employ additional health and safety measures specified by the Safety Consultant, as necessary, for workers in accordance with OSHA guidelines.

C. Transmit to OWNER and ENGINEER copies of reports and other documents related to accidents or injuries encountered during construction.

PART 2 PRODUCTS

Not used.

PART 3 EXECUTION

Not used.

END OF SECTION

SECTION 01450

QUALITY CONTROL

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Quality control requirements and procedures for products and workmanship and includes the following:
   1. Sampling and testing of materials.
   2. Testing of equipment.
   3. Requirements for testing laboratories.
   4. Procedures and limitations of inspection.

1.02 REFERENCES

A. ASTM International (ASTM):
   1. E 329 - Standard Specification for Agencies Engaged in Construction Inspection and/or Testing.

1.03 PRODUCTS AND WORKMANSHIP

A. Provide new products of specified quality, and equal to accepted samples when samples were submitted.

B. Perform and complete work in thorough manner:
   1. Call OWNER's attention to apparent errors, conflicts, discrepancies, or omissions in Contract Documents and request instructions before proceeding with the Work.
   2. OWNER will issue written clarification or interpretation of requirements of the Contract Documents.

C. When specified, products will be tested and inspected either at point of origin or at work site:
   1. Notify OWNER in writing well in advance of when products will be ready for testing and inspection at point of origin.
   2. Do not construe that satisfactory tests and inspections at point of origin is final acceptance of products. Satisfactory tests or inspections at point of origin do not preclude retesting or reinspection at work site.

D. Do not ship products which require testing and inspection at point of origin prior to testing and inspection.

1.04 INSPECTION

A. Material and equipment, and workmanship shall be subject to inspection and rejection when not in conformance with Contract Documents.

B. Remove defective work and products from work site, whether in place or not, and replace or renew with work, material, or equipment in conformance with Contract Documents.

C. Questions concerning acceptability of materials, classification of materials, and execution of the Work will be decided by ENGINEER.

D. Facilitate inspection by maintaining proper facilities and providing safe access to the Work, to shops where products are in preparation, and to warehouses and storage yards where products are stored.

1.05 SAMPLING AND TESTING

A. General:
   1. Prior to delivery and incorporation in the Work, submit listing of sources of materials, when specified in sections where materials are specified.
   2. When specified in sections where products are specified:
      a. Submit sufficient quantities of representative samples of character and quality required of materials to be used in the Work for testing or examination.
      b. Test materials in accordance with standards of national technical organizations.

B. Sampling:
   1. Furnish specimens of materials when requested.
   2. Do not use materials which are required to be tested until testing indicates satisfactory compliance with specified requirements.
   3. Specimens of materials will be taken for testing whenever necessary to determine quality of material.
   4. Assist OWNER's representative in preparation of test specimens at site of work, such as soil samples and concrete test cylinders.

C. Testing:
   1. OWNER will employ and pay for services of independent testing laboratory to perform routine tests of materials to confirm compliance with requirements of Contract Documents:
      a. Mill tests, soil compaction test, concrete cylinder tests, and other specified tests shall be paid for by OWNER.
   2. When protesting failed tests of material in place or to be used, take additional specimens and have specimens tested:
      a. When original test proves to have been in error, file claim for reimbursement of direct costs for sampling and testing.

D. Test standards:
   1. Perform sampling, specimen preparation, and testing of materials in accordance with specified standards, and when no standard is specified, in accordance with standard of nationally recognized technical organization.
   2. Physical characteristics of materials not particularly specified shall conform to standards published by ASTM, where applicable.

1.06 TESTING LABORATORY SERVICES

A. Qualification of laboratory:
   1. Meets "Recommended Requirements for Independent Laboratory Qualification," published by American Council of Independent Laboratories.
   2. Meets requirements of ASTM E 329. and AASHTO R18.
   3. Has authorization to operate in state in which Project is located.
   4. Will submit copy of report of inspection of facilities made by Materials Reference Laboratory of the National Bureau of Standards during most recent tour of inspection, with memorandum of remedies of deficiencies reported by inspection.
   5. Has testing equipment calibrated at reasonable intervals by devices of accuracy traceable to NBS or accepted values of natural physical constants.

B. Laboratory duties:
   1. Cooperate with ENGINEER and CONTRACTOR.
   2. Provide qualified personnel.
   3. Notify ENGINEER and CONTRACTOR, in writing, of response time needed to schedule testing or inspections after receipt of notice.
   4. Perform specified inspections, sampling, and testing of materials and methods of construction in accordance with specified standards to ascertain compliance of materials with requirements of Contract Documents.
   5. Promptly notify ENGINEER and CONTRACTOR of observed irregularities or deficiencies of construction.
   6. Promptly submit written report of each test and inspection; 1 copy each to ENGINEER, OWNER, CONTRACTOR, and 1 copy to file of Project Record Documents. Each report shall include:
      a. Date issued.
      b. Project title and number.
      c. Testing laboratory name, address, and telephone number.
      d. Name and signature of laboratory inspector.
      e. Date and time of sampling or inspection.
      f. Record of temperature and weather conditions.
      g. Date of test.
      h. Identification of product and Specification Section.
      i. Location of sample or test in Project.
      j. Type of inspection or test.
      k. Results of tests and compliance with Contract Documents.
      l. Interpretation of test results, when requested by ENGINEER.

C. Limitations of authority of testing laboratory: Laboratory is not authorized to:
   1. Release, revoke, alter, or enlarge on requirements of Contract Documents.
   2. Approve or accept portion of work.
   3. Perform duties of CONTRACTOR.

1.07 CONTRACTOR'S RESPONSIBILITIES

A. Cooperate with laboratory personnel and provide access to construction and manufacturing operations.

B. Secure and deliver to laboratory adequate quantities of representative samples of materials proposed to be used and which require testing.

C. Provide to laboratory preliminary mix design proposed to be used for concrete, and other materials mixes which require control by testing laboratory.

D. Furnish copies of product test reports.

E. Furnish incidental labor and facilities:
   1. To provide access to construction to be tested.
   2. To obtain and handle samples at work site or at source of product to be tested.
   3. To facilitate inspections and tests.
   4. For storage and curing of test samples.

F. Notify laboratory in advance of when observations, inspections and testing is needed for laboratory to schedule and perform in accordance with their notice of response time.

PART 2 PRODUCTS

Not used.

PART 3 EXECUTION

Not used.

END OF SECTION

SECTION 01455

SPECIAL TESTS AND INSPECTIONS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: This Section describes the requirements for providing special tests and inspections required by Laws and Regulations.

B. Related sections:
   1. The Contract Documents are complementary; what is called for by one is as binding as if called for by all.
   2. It is the CONTRACTOR's responsibility for scheduling and coordinating the Work of subcontractors, suppliers, and other individuals or entities performing or furnishing any of CONTRACTOR's Work.
   3. The following Sections are related to the Work described in this Section. This list of Related Sections is provided for convenience only and is not intended to excuse or otherwise diminish the duty of the CONTRACTOR to see that the completed Work complies accurately with the Contract Documents.
      a. Section 01450 - Quality Control.

1.02 REFERENCES

A. International Building Code (IBC).

1.03 DESCRIPTION

A. This Section describes special tests and inspections of structural assemblies and components to be performed in compliance with IBC.

B. These special tests and inspections are in addition to the requirements specified in Section 01450, and by the individual Sections

C. The engineer of record acting as the OWNER's agent will employ 1 or more inspectors who will provide special inspections during construction.

1.04 INSPECTION

A. Duties of Special Inspector:
   1. General: Required duties of the Special Inspector are described in IBC.

1.05 TESTS

A. Selection of the material required to be tested shall be by the OWNER's Testing Laboratory and not the CONTRACTOR.

1.06 SPECIAL TESTING AND INSPECTIONS

A. Testing laboratory: Special tests will be performed by the OWNER's testing laboratory as specified in Section 01450.

B. The following types of work require special inspection as described in IBC. Refer to the following verification, testing, and inspection schedules.
   1. Appendix A, Cast-In-Place Concrete Special Inspection Schedule.
   2. Appendix B, Soils Verification, and Inspection Schedule.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

3.01 SCHEDULE

A. The CONTRACTOR shall allow time necessary for Special Inspections as listed above.

B. Sufficient notice shall be given so that the Special Inspections can be performed. This includes time for off-site Special Inspectors to plan the inspection and travel to site.

3.02 PROCEDURE

A. The Special Inspector will immediately notify the ENGINEER of any corrections required and follow notification with appropriate documentation.

B. The CONTRACTOR shall not proceed until the work is satisfactory to the ENGINEER.

END OF SECTION

APPENDIX A
CAST-IN-PLACE CONCRETE SPECIAL INSPECTION SCHEDULE

Verification and Inspection	Reference Standard	Frequency of Inspection	
		Continuous During Task Listed	Continuous During Task Listed
1. Inspection of reinforcing steel, including prestressing tendons, and placement.		–	X
2. Inspection of reinforcing steel welding.	IBC Table 1704.3, Item 5B	–	–
3. Inspect bolts to be installed in concrete prior to and during placement of concrete.		X	–
4. Verifying use of required design mix.		–	X
5. At the time fresh concrete is sampled to fabricate specimens for strength tests, perform slump and air content tests, and determine the temperature of the concrete.		X	–
6. Inspection of concrete and shotcrete placement for proper application techniques.		X	–
7. Inspection for maintenance of specified curing temperature and techniques.		–	X

APPENDIX B
SOILS VERIFICATION AND INSPECTION SCHEDULE

Verification and Inspection	Reference Standard	Frequency of Inspection	
		Continuous During Task Listed	Periodic During Task Listed
1. Verify materials below footings are adequate to achieve the design bearing capacity.		–	X
2. Verify excavations are extended to proper depth and have reached proper material.		–	X
3. Perform classification and testing of controlled fill materials.		–	X
4. Verify use of proper materials, densities, and lift thicknesses during placement and compaction of controlled fill.		X	–
5. Prior to placement of controlled fill, observe subgrade and verify that site has been prepared properly.		–	X

SECTION 01500

TEMPORARY FACILITIES AND CONTROLS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Furnishing, maintaining, and removing construction facilities and temporary controls, including temporary utilities, construction aids, barriers and enclosures, security, access roads, temporary controls, project sign, field offices and sheds, and removal after construction.

1.02 SUBMITTALS

A. General: For products specified to be furnished under this Section, submit product data in accordance with Section 01330.

1.03 TEMPORARY UTILITIES

A. Temporary electrical power:
   1. Arrange with local utility to provide adequate temporary electrical service.
   2. Provide and maintain adequate jobsite power distribution facilities conforming to applicable Laws and Regulations.
   3. Provide, maintain, and pay for electric power for performance of the Work except for power required for the final 7-day operational test:
      a. When using permanent facilities, provide separate meter and reimburse OWNER for power used in connection with performance of the Work.

B. Temporary electrical lighting:
   1. In work areas, provide temporary lighting sufficient to maintain lighting levels during working hours not less than lighting levels required by Occupational Safety and Health Administration (OSHA) and state agency which administers OSHA regulations where Project is located.
   2. When available, permanent lighting facilities may be used in lieu of temporary facilities:
      a. Prior to final acceptance of the Work, replace bulbs, lamps, or tubes used by CONTRACTOR for lighting.

C. Temporary water:
   1. Pay for and construct facilities necessary to furnish potable water for human consumption and non-potable water for use during construction.
   2. Remove temporary piping and connections and restore affected portions of the facility to original condition before final acceptance.

D. Temporary sanitary facilities:
   1. Provide suitable and adequate sanitary facilities that are in compliance with applicable laws and regulations.
   2. At completion of the Work, remove sanitary facilities and leave site in neat and sanitary condition.

E. Temporary fire protection: Provide sufficient number of fire extinguishers of type and capacity required to protect the Work and ancillary facilities.

F. First aid: Post first aid facilities and information posters conforming to requirements of OSHA and other applicable Laws and Regulations in readily accessible locations.

G. Utilities in existing facilities: See Section 01140.

1.04 CONSTRUCTION AIDS

A. Provide railings, kick plates, enclosures, safety devices, and controls required by Laws and Regulations and as required for adequate protection of life and property.

B. Use construction hoists, elevators, scaffolds, stages, shoring, and similar temporary facilities of ample size and capacity to adequately support and move loads.

C. Design temporary supports with adequate safety factor to assure adequate load bearing capability:
   1. When requested, submit design calculations by professional registered engineer prior to application of loads.
   2. Submitted design calculations are for information and record purposes only.

D. Accident prevention:
   1. Exercise precautions throughout construction for protection of persons and property.
   2. Observe safety provisions of applicable Laws and Regulations.
   3. Guard machinery and equipment, and eliminate other hazards.
   4. Make reports required by authorities having jurisdiction, and permit safety inspections of the Work.
   5. Before commencing construction work, take necessary action to comply with provisions for safety and accident prevention.

E. Barricades:
   1. Place barriers at ends of excavations and along excavations to warn pedestrian and vehicular traffic of excavations.
   2. Provide barriers with flashing lights after dark.
   3. Keep barriers in place until excavations are entirely backfilled and compacted.
   4. Barricade excavations to prevent persons from entering excavated areas in streets, roadways, parking lots, treatment plants, or other public or private areas.

F. Warning devices and barricades: Adequately identify and guard hazardous areas and conditions by visual warning devices and, where necessary, physical barriers:
   1. Devices shall conform to minimum requirements of OSHA and State agency which administers OSHA regulations where Project is located.

G. Hazards in protected areas: Mark or guard excavations in areas from which public is excluded, in manner appropriate for hazard.

H. Above grade protection: On multi-level structures, provide safety protection that meets requirements of OSHA and State agency which administers OSHA regulations where Project is located.

I. Protect existing structures, trees, shrubs, and other items to be preserved on Project site from injury, damage or destruction by vehicles, equipment, worker or other agents with substantial barricades or other devices commensurate with hazards.

1.05 ACCESS ROADS

A. On-site access roads:
   1. Maintain access roads to storage areas and other areas to which frequent access is required.
   2. Maintain similar roads to existing facilities on site of the Work to provide access for maintenance and operation.
   3. Protect buried vulnerable utilities under temporary roads with steel plates, wood planking, or bridges.
   4. Maintain on-site access roads free of mud. Under no circumstances shall vehicles leaving the site track mud off the site onto the public right-of-way.

1.06 TEMPORARY CONTROLS

A. Dust control:
   1. Prevent dust nuisance caused by operations, unpaved roads, excavation, backfilling, demolition, or other activities.
   2. Control dust by sprinkling with water, use of dust palliatives, modification of operations, or other means acceptable to agencies having jurisdiction.

B. Noise control:
   1. In inhabited areas, particularly residential, perform operations in manner to minimize noise.
   2. In residential areas, take special measures to suppress noise during night hours.

C. Mud control:
   1. Prevent mud nuisance caused by construction operations, unpaved roads, excavation, backfilling, demolition, or other activities.

1.07 FIELD OFFICES AND FACILITIES

A. Not required for this Work.

1.08 REMOVAL

A. Remove temporary buildings and furnishings before inspection for final completion or when directed.

B. Clean and repair damage caused by installation or use of temporary facilities.

C. Remove underground installations to minimum depth of 24 inches and grade to match surrounding conditions.

D. Restore existing facilities used during construction to specified or original condition.

PART 2 PRODUCTS

Not used.

PART 3 EXECUTION

Not used.

END OF SECTION

SECTION 01600

PRODUCT REQUIREMENTS

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes: Product requirements; product selection; products schedule; execution; manufacturer's instructions; and delivery, handling, and storage.

1.02 PRODUCT REQUIREMENTS

A. Comply with Specifications and referenced standards as minimum requirements.

B. Provide products by same manufacturer when products are of similar nature, unless otherwise specified.

C. Provide identical products when products are required in quantity.

D. Provide products with interchangeable parts whenever possible.

E. Require each equipment manufacturer to have maintenance facilities meeting the following requirements:
   1. Minimum 3 years operational experience.
   2. Location in continental United States, with a local representative in Phoenix, Arizona.
   3. Equipment and tools capable of making repairs.
   4. Staff qualified to make repairs.
   5. Inventory of maintenance spare parts.

1.03 PRODUCT SELECTION

A. When products are specified by standard or specification designations of technical societies, organizations, or associations only, provide products which meet or exceed reference standard and Specifications.

B. When products are specified with names of manufacturers but no model numbers or catalog designations, provide:
   1. Products by one of named manufacturers which meets or exceeds Specifications.
   2. Accepted or equals.

C. When products are specified with names of manufacturers and model numbers or catalog designations, provide:
   1. Products with model numbers or catalog designations by 1 of named manufacturers.
   2. Accepted or equals.

D. When products are specified with names of manufacturers, but with brand or trade names, model numbers, or catalog designations by 1 manufacturer only, provide:
   1. Products specified by brand or trade name, model number, or catalog designation.
   2. Products by 1 of named manufacturers proven in accordance with requirements for or-equals to meet or exceed quality, appearance and performance of specified brand or trade name, model number, or catalog designation.
   3. Accepted or equals.

E. When Products are specified with only 1 manufacturer followed by "or Equal," provide:
   1. Products meeting or exceeding Specifications by specified manufacturer.
   2. Accepted or equals.

F. When products are specified with only one manufacturer followed by "Required", or followed by "No Exceptions," or "No Substitutes," provide that product. Some items or equipment have been standardized by the OWNER and no substitutions are allowed.

1.04 PRODUCT OPTIONS AND SUBSTITUTIONS

A. General: Whenever a product is specified using a name of a particular manufacturer or supplier, the specific item cited shall be understood as establishing type, function, dimension, appearance, and quality desired. Other manufacturer's products will only be considered for acceptance provided sufficient information is submitted to the ENGINEER for review to determine that the products proposed are equivalent to those named and the OWNER will accept the proposed substitute. OWNER maintains the right to reject any proposed substitute not submitted during the Bid process, for any reason.

1.05 QUALITY ASSURANCE

A. Employ entities that meet or exceed specified qualifications, to execute the Work.

B. Inspect conditions before executing subsequent portions of the Work. Accept responsibility for correcting unsatisfactory conditions upon executing subsequent portions of the Work.

C. Secure products in place with positive anchorage devices designed and sized to withstand stresses, vibration, and racking.

1.06 DELIVERY, HANDLING, AND STORAGE

A. Prepare Products for Shipment by:
   1. Applying grease and lubricating oil to bearings and similar items.
   2. Separately packing or otherwise suitably protecting bearings.
   3. Tagging or marking products to agree with delivery schedule or Shop Drawings.
   4. Including complete packing lists and bills of material with each shipment.
   5. Packaging products to facilitate handling and protection against damage during transit, handling, and storage.

B. Transport products by methods that avoid product damage. Deliver products in undamaged condition in manufacturer's unopened containers or packaging.

C. Provide equipment and personnel to handle products by methods to prevent soiling or damage.

D. Upon delivery, promptly inspect shipments. Verify compliance with Contract Documents, correct quantities and undamaged condition of products. Immediately store and protect products and materials until installed in Work.

E. Store products with seals and legible labels intact.

F. Store moisture sensitive products in weathertight enclosures.

G. Maintain products within temperature and humidity ranges required or recommended by manufacturer.

H. Connect and operate space heaters during storage when ambient temperatures fall below temperatures recommended by manufacturer.

I. Protect painted surfaces against impact, abrasion, discoloration, and other damage. Repaint damaged painted surfaces.

J. Exterior Storage of Fabricated Products:
   1. Place on above ground supports which allow for drainage.
   2. Cover products subject to deterioration with impervious sheet covering.
   3. Provide ventilation to prevent condensation under covering.

K. Store loose granular materials on solid surfaces in well-drained area. Prevent materials mixing with foreign matter.

L. Provide access for inspection.

M. Maintain equipment per the manufacturer's recommendation and industry standards, including oil changes, rotation, etc. Provide a log of equipment maintenance to the ENGINEER, on a monthly basis.

N. Periodically inspect to assure products are undamaged and maintained under required conditions.

1.07 MANUFACTURER'S INSTRUCTIONS

A. Deliver, handle, store, install, erect, or apply products in accordance with manufacturer's instructions, Contract Documents, and industry standards.

B. Periodically inspect to assure products are undamaged and maintained under required conditions.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

Not Used.

END OF SECTION

SECTION 01612

SEISMIC DESIGN CRITERIA

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Seismic design criteria for the following:
   1. Anchorage of mechanical and electrical equipment.
   2. Seismic design of tanks and anchorage of tanks.
   3. Other structures or items as specified or indicated on the Drawings.

1.02 SYSTEM DESCRIPTION

A. Design requirements:
   1. Design in accordance with the requirements of the building code as specified in Section 01410.
      a. Seismic design category: B.
      b. Site Class D; S_{DS}: 0.20, S_{D1} 0.10.
      c. Seismic component importance factor for the design and anchorage of tanks, architectural, mechanical, and electrical equipment, I_p as follows:

Component	Component Importance Factor, I_p
Fire protection sprinkler systems	1.5
Chlorine systems	1.5
All other components	1.0

   2. Do not use friction to resist sliding due to seismic forces.
   3. Do not use more than 60 percent of the weight of the mechanical and electrical equipment for designing anchors for resisting overturning due to seismic forces.
   4. Do not use more than 60 percent of the weight of the tank for resisting overturning due to seismic forces.
   5. Use anchor bolts, bolts, or welded studs for anchors for resisting seismic forces. Anchor bolts used to resist seismic forces shall have a standard hex bolt head. Do not use anchor bolts fabricated from rod stock with an L or J shape.
   6. Do not use chemical anchors, concrete anchors, flush shells, powder actuated fasteners, sleeve anchors, or other types of anchors unless indicated on the Drawings or accepted in writing by the ENGINEER.
   7. Seismic forces must be resisted by direct bearing on the fasteners used to resist seismic forces. Do not use connections that use friction to resist seismic forces.

1.03 SUBMITTALS

A. Shop drawings and calculations: Complete shop drawings and seismic calculations.

B. Calculations shall be signed and stamped by a civil or structural engineer licensed to practice in the state where the Project is located.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

Not Used.

END OF SECTION

SECTION 01614

WIND DESIGN CRITERIA

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Wind design criteria.

1.02 SYSTEM DESCRIPTION

A. Design requirements:
   1. Building code criteria: Design for wind in accordance with Building Code as specified in Section 01410.
      a. Basic wind speed: 90 miles per hour.
      b. Wind exposure: C.
      c. Wind importance factor, I_w: 1.15.
   2. Use anchor bolts, bolts, or welded studs for anchors for resisting wind forces. Anchor bolts used to resist wind forces shall have a standard hex bolt head. Do not use anchor bolts fabricated from rod stock with an L or J shape.
      a. Do not use concrete anchors, sleeve anchors, flush shells, chemical anchors, powder actuated fasteners, or other types of anchor unless indicated on the Drawings or accepted in writing by the ENGINEER.
      b. Wind forces must be resisted by direct bearing on the anchors used to resist wind forces. Do not use connections which use friction to resist wind forces.

1.03 SUBMITTALS

A. Shop drawings and calculations: Complete shop drawings and wind design calculations.

B. Calculations shall be signed and stamped by a Civil or Structural Engineer registered in the state where the Project is located.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

Not Used.

END OF SECTION

SECTION 01722

FIELD ENGINEERING

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Field engineering to establish lines and grades for the Work.

1.02 QUALITY ASSURANCE

A. Qualifications of surveyor or engineer: Registered civil engineer or land surveyor in state where Project is located.

B. Accuracy of stakes, alignments, and grades may be checked randomly by ENGINEER:
   1. Notice of when checking will be conducted will be given.
   2. When notice of checking is given, postpone parts of the Work affected by stakes, alignments, or grades to be checked until checked.
   3. Do not assume that ENGINEER's check substitutes or complements required field quality control procedures.

1.03 CONSTRUCTION STAKES, LINES, AND GRADES

A. Execute the Work in accordance with the lines and grades indicated.

B. Make distances and measurements on horizontal planes, except elevations and structural dimensions.

1.04 SURVEY REFERENCE POINTS

A. Basic reference line, a beginning point on basic reference line, and a benchmark will be provided, by OWNER.

B. From these reference points, establish other control and reference points as required to properly lay out the Work.

C. Locate and protect control points prior to starting site work, and preserve permanent reference points during construction:
   1. Make no changes or relocations without prior written notice.
   2. Replace Project control point, when lost or destroyed, in accordance with original survey control.

D. Set monuments for principal control points and protect them from being disturbed and displaced;
   1. Re-establish disturbed monuments.
   2. When disturbed, postpone parts of the Work that are governed by disturbed monuments until such monuments are re-established.

1.05 PROJECT SURVEY REQUIREMENTS

A. Establish minimum of 2 permanent benchmarks on site referenced to data established by survey control points.

B. Record permanent benchmark locations with horizontal and vertical data on project record documents.

C. Assume responsibility for accuracy of stakes, alignments, and grades by performing verifications and checking in accordance with standard surveying practice.

1.06 RECORD DOCUMENTS

A. Prepare and submit record documents as specified in Section 01770.

B. Maintain complete, accurate log of control points and survey.

C. Affix civil engineer's or land surveyor's signature and registration number to Record drawing to certify accuracy of information shown.

PART 2 PRODUCTS

Not used.

PART 3 EXECUTION

Not used.

END OF SECTION

SECTION 01732

CUTTING AND PATCHING

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Cutting and patching existing and new construction.

1.02 SUBMITTALS

A. Submit in accordance with Section 01330.

B. Cutting and patching plan:
   1. Submit details of proposed construction before cutting and patching construction commences affecting:
      a. Work of OWNER or of others.
      b. Structural integrity of element of Project.
   2. Cutting and patching plan shall include the following:
      a. Identification of work.
      b. Description of affected construction.
      c. Necessity for cutting, patching, alteration, or excavation.
      d. Description of proposed construction.
      e. Scope of cutting, patching, alteration, or excavation.

PART 2 PRODUCTS

2.01 MATERIALS

A. Comply with specifications and standards for products involved.

PART 3 EXECUTION

3.01 PREPARATION

A. Provide adequate temporary support as necessary to ensure structural integrity of affected portion of Work.

B. Provide devices and methods to protect other portions of Project from damage and persons from injury.

C. Provide protection from elements for that portion of Project which may be exposed by cutting and patching, and maintain excavations free from water.

3.02 CUTTING AND PATCHING

A. Cut, fit, and patch when required to:
   1. Make its several parts fit together properly.

2. Remove and replace construction not conforming to Contract Documents.
3. Remove samples of installed construction as specified for testing.
4. Provide routine penetrations of nonstructural surfaces for installation of piping and electrical conduit.

B. Execute cutting and demolition by methods which will prevent damage and will provide proper surfaces to receive installation of repairs.

C. Openings in existing concrete and masonry:
1. Create openings by:
   a. Saw cutting completely through concrete or masonry, or
   b. Scoring edges of opening with saw to at least 1 inch depth on both surfaces (when accessible) and removing concrete or masonry by chipping.
2. Do not allow saw cuts to extend beyond limits of opening.
3. Make corners square and true by combination of core drilling and grinding or chipping.
4. Prevent debris from falling into adjacent tanks or channels in service or from damaging existing equipment and other facilities.

D. Sizing of openings in existing concrete or masonry:
1. Make openings sufficiently large to permit final alignment of pipe and fittings without deflections.
2. Allow adequate space for packing around pipes and conduit to ensure watertightness.

E. Grouting pipes in place:
1. Sandblast concrete surfaces and thoroughly clean sand and other foreign material from surfaces prior to placing grout.
2. Grout pipes, sleeves, castings, and conduits in place by pouring grout under a head of at least 4 inches. Vibrate grout into place. Completely fill the spaces occupied by pipes, sleeves, castings, and conduits.
3. Water cure the grout.

F. Connections to existing pipes:
1. Cut existing pipe square.
2. Properly prepare the ends for the connection indicated on the Drawings.
3. Repair any damage to existing lining and coating.

G. Rehabilitate all areas affected by removal of existing equipment, equipment pads and bases, piping, supports, electrical panels, electric devices, and conduits such that little or no evidence of the previous installation remains:
1. Fill areas in existing floors, walls, and ceilings from removed piping, conduit, and fasteners with non-shrink grout and finish smooth.
2. Remove concrete bases for equipment and supports by:
   a. Saw cutting clean, straight lines with a depth equal to the concrete cover over reinforcement minus 1/2 inch below finished surface. Do not cut existing reinforcement on floors.
   b. Chip concrete within scored lines and cut exposed reinforcing steel and anchor bolts.
   c. Patch with non-shrink grout to match adjacent grade and finish.
3. Terminate abandoned piping and conduits with blind flanges, caps, or plugs.

H. Treat existing concrete reinforcement as follows:
   1. Where existing reinforcement is to remain, protect, clean, and extend into new concrete.
   2. Where existing reinforcement is not to be retained, cut off as follows:
      a. Where new concrete joins existing concrete at the removal line, cut reinforcement flush with concrete surface at the removal line.
      b. Where concrete surface at the removal line is the finished surface, cut reinforcement 2 inches below the surface, paint ends with epoxy, and patch holes with dry pack mortar.

END OF SECTION

SECTION 01756

TESTING, TRAINING, AND FACILITY START-UP

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Requirements for equipment and system testing and facility start up, including the following:
   1. Start-up plan.
   2. Performance testing.
   3. General start-up and testing procedures.
   4. Functional testing.
   5. Operational testing.
   6. Certificate of proper installation.
   7. Services of manufacturer's representatives.
   8. Training of OWNER's personnel.
   9. Final testing requirements for the complete facility.

1.02 GENERAL TESTING, TRAINING, AND START-UP REQUIREMENTS

A. Contract requirements: Testing, training, and start-up are requisite to the satisfactory completion of the Contract.

B. Complete testing, training, and start-up within the Contract Times.

C. Allow realistic durations in the Progress Schedule for testing, training, and start-up activities.

D. Furnish labor, power, chemicals, tools, equipment, instruments, and services required for and incidental to completing functional testing, performance testing, and operational testing.

E. Provide competent, experienced technical representatives of equipment manufacturers for assembly, installation and testing guidance, and operator training.

1.03 START-UP PLAN

A. Submit start-up plan for each piece of equipment and each system not less than 3 weeks prior to planned initial start-up of equipment or system.

B. Provide detailed sub-network of progress schedule with the following activities identified:
   1. Manufacturer's services.
   2. Installation certifications.
   3. Operator training.
   4. Submission of Operation and Maintenance Manual.
   5. Functional testing.
   6. Performance testing.
   7. Operational testing.

C. Provide testing plan with test logs for each item of equipment and each system when specified. Include testing of alarms, control circuits, capacities, speeds, flows, pressures, vibrations, sound levels, and other parameters.

D. Provide summary of shutdown requirements for existing systems which are necessary to complete start-up of new equipment and systems for operator review and approval.

E. Provide a Maintenance of Plant Operations (MOPO) plan for any start-up that requires bypassing or shutdown of existing operations.

F. Revise and update start-up plan based upon review comments, actual progress, or to accommodate changes in the sequence of activities.

1.04 PERFORMANCE TESTING

A. Test equipment for proper performance at point of manufacture or assembly when specified.

B. When source quality control testing is specified:
   1. Demonstrate equipment meets specified performance requirements.
   2. Provide certified copies of test results.
   3. Do not ship equipment until certified copies have received written acceptance from ENGINEER. Written acceptance does not constitute final acceptance.
   4. Perform testing as specified in the equipment specification sections.

1.05 GENERAL START-UP AND TESTING PROCEDURES

A. Mechanical systems: As specified in the individual equipment specification sections and Sections 15050 and 15958, if included in the documents.
   1. Remove rust preventatives and oils applied to protect equipment during construction.
   2. Flush lubrication systems and dispose of flushing oils. Recharge lubrication system with lubricant recommended by manufacturer.
   3. Flush fuel system and provide fuel for testing and start-up.
   4. Install and adjust packing, mechanical seals, O-rings, and other seals. Replace defective seals.
   5. Remove temporary supports, bracing, or other foreign objects installed to prevent damage during shipment, storage, and erection.
   6. Check rotating machinery for correct direction of rotation and for freedom of moving parts before connecting driver.
   7. Perform cold alignment and hot alignment to manufacturer's tolerances.
   8. Adjust V-belt tension and variable pitch sheaves.
   9. Inspect hand and motorized valves for proper adjustment. Tighten packing glands to insure no leakage, but permit valve stems to rotate without galling. Verify valve seats are positioned for proper flow direction.
   10. Tighten leaking flanges or replace flange gasket. Inspect screwed joints for leakage.
   11. Install gratings, safety chains, handrails, shaft guards, and sidewalks prior to operational testing.

B. Electrical systems: As specified in Section 16950 and the individual equipment specification sections if included:
   1. Perform insulation resistance tests on wiring except 120 volt lighting, wiring, and control wiring inside electrical panels.
   2. Perform continuity tests on grounding systems.
   3. Test and set switchgear and circuit breaker relays for proper operation.
   4. Perform direct current high potential tests on all cables that will operate at more than 2,000 volts. Obtain services of independent testing lab to perform tests.
   5. Check motors for actual full load amperage draw. Compare to nameplate value.

C. Instrumentation systems: As specified in the individual equipment specification sections:
   1. Bench or field calibrate instruments and make required adjustments and control point settings.
   2. Leak test pneumatic controls and instrument air piping.
   3. Energize transmitting and control signal systems, verify proper operation, ranges, and settings.

1.06 FUNCTIONAL TESTING

A. Perform checkout and performance testing as specified in the individual equipment specification sections.

B. Functionally test mechanical and electrical equipment, and instrumentation and controls systems for proper operation after general start-up and testing tasks have been completed.

C. Demonstrate proper rotation, alignment, speed, flow, pressure, vibration, sound level, adjustments, and calibration. Perform initial checks in the presence of and with the assistance of the manufacturer's representative.

D. Demonstrate proper operation of each instrument loop function including alarms, local and remote controls, instrumentation and other equipment functions. Generate signals with test equipment to simulate operating conditions in each control mode.

E. Conduct continuous 8-hour test under full load conditions. Replace parts which operate improperly.

1.07 OPERATIONAL TESTING

A. After completion of operator training, conduct operational test of the entire facility. Demonstrate satisfactory operation of equipment and systems in actual operation.

B. Conduct operational test for continuous 7-day period.

C. OWNER will provide operations personnel, power, fuel, and other consumables for duration of test.

D. Immediately correct defects in material, workmanship, or equipment which became evident during operational test.

E. Repeat operational test when malfunctions or deficiencies cause shutdown or partial operation of the facility or results in performance that is less than specified.

1.08 CERTIFICATE OF PROPER INSTALLATION

A. At completion of functional testing, furnish written report prepared and signed by manufacturer's authorized representative, certifying equipment:
   1. Has been properly installed, adjusted, aligned, and lubricated.
   2. Is free of any stresses imposed by connecting piping or anchor bolts.
   3. Is suitable for satisfactory full-time operation under full load conditions.
   4. Operates within the allowable limits for vibration.
   5. Controls, protective devices, instrumentation, and control panels furnished as part of the equipment package are properly installed, calibrated, and functioning.
   6. Control logic for start-up, shutdown, sequencing, interlocks, and emergency shutdown have been tested and are properly functioning.

B. Furnish written report prepared and signed by the electrical and/or instrumentation subcontractor certifying:
   1. Motor control logic that resides in motor control centers, control panels, and circuit boards furnished by the electrical and/or instrumentation subcontractor has been calibrated and tested and is properly operating.
   2. Control logic for equipment start-up, shutdown, sequencing, interlocks and emergency shutdown has been tested and is properly operating.
   3. Co-sign the reports along with the manufacturer's representative and subcontractors.

1.09 TRAINING OF OWNER'S PERSONNEL

A. Provide operations and maintenance training for items of mechanical, electrical and instrumentation equipment. Utilize manufacturer's representatives to conduct training sessions.

B. Coordinate training sessions to prevent overlapping sessions. Arrange sessions so that individual operators and maintenance technicians do not attend more than 2 sessions per week.

C. Provide operation and maintenance manual for specific pieces of equipment or systems a minimum of one (1) month prior to training session for that piece of equipment or system.

D. Satisfactorily complete functional testing before beginning operator training.

E. Provide training sessions for each work shift listed below during the time periods shown. Pooling of shifts will not be permitted unless accepted by OWNER.

Shift		
Day	Tuesday, 7 a.m.-11 a.m.	Thursday, 7 a.m.-11 a.m.
Swing	Wednesday, 3 p.m.-7 p.m.	Thursday, 3 p.m.-7 p.m.

F. Training sessions: Provide training sessions for equipment as specified in the individual equipment specification sections.

G. The CONTRACTOR shall videotape all training sessions and provide a copy for the OWNER.

H. The CONTRACTOR shall designate and provide one or more persons to be responsible for coordinating and expediting his/her training duties. The person or persons so designated shall be present at all training coordination meetings with the OWNER.

I. The CONTRACTOR's coordinator shall coordinate the training periods with OWNER personnel and manufacturer's representatives, and shall submit a training schedule for each piece of equipment or system for which training is to be provided. Such training schedule shall be submitted not less than 21 calendar days prior to the time that the associated training is to be provided and shall be based on the current plan of operation.

1.10 RECORD KEEPING

A. Maintain and submit following records generated during start-up and testing phase of Project:
   1. Daily logs of equipment testing identifying all tests conducted and outcome.
   2. Logs of time spent by manufacturer's representatives performing services on the job site.
   3. Equipment lubrication records.
   4. Electrical phase, voltage, and amperage measurements.
   5. Insulation resistance measurements.
   6. Data sheets of control loop testing including testing and calibration of instrumentation devices and setpoints.

PART 2 PRODUCTS

Not used.

PART 3 EXECUTION

Not used.

END OF SECTION

SECTION 01770

CLOSEOUT PROCEDURES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Contract closeout requirements including:
   1. Final cleaning.
   2. Waste disposal.
   3. Touch-up and repair.
   4. Disinfection of systems.
   5. Preparation and submittal of closeout documents.
   6. Final completion certification.

1.02 FINAL CLEANING

A. Perform final cleaning prior to inspections for final acceptance.

B. Employ skilled workers who are experienced in cleaning operations.

C. Use cleaning materials which are recommended by manufacturers of surfaces to be cleaned.

D. Prevent scratching, discoloring, and otherwise damaging surfaces being cleaned.

E. Broom clean exterior paved surfaces and rake clean other surfaces of site work:
   1. Police yards and grounds to keep clean.

F. Remove dust, cobwebs, and traces of insects and dirt.

G. Clean grease, mastic, adhesives, dust, dirt, stains, fingerprints, paint, blemishes, sealants, plaster, concrete, and other foreign materials from sight-exposed surfaces, and fixtures and equipment.

H. Remove non-permanent protection and labels.

1.03 WASTE DISPOSAL

A. Arrange for and dispose of surplus materials, waste products, and debris off-site:
   1. Prior to making disposal on private property, obtain written permission from OWNER of such property.

B. Do not fill ditches, washes, or drainage ways which may create drainage problems.

C. Do not create unsightly or unsanitary nuisances during disposal operations.

D. Maintain disposal site in safe condition and good appearance.

E. Complete leveling and cleanup prior to final acceptance of the Work.

1.04 TOUCH-UP AND REPAIR

A. Touch-up or repair finished surfaces on structures, equipment, fixtures, and installations that have been damaged prior to inspection for final acceptance.

B. Refinish or replace entire surfaces which cannot be touched-up or repaired satisfactorily.

1.05 FINAL CLEANING AND STERILIZATION OF SYSTEMS OF PLANT FACILITIES

A. Clean channels, pipe, basins, reservoirs, and tanks before running of 7-day test, or before facility goes on stream when 7-day test is not required.

B. Wash, wherever practicable, or broom sweep channels, pipe, basins, reservoirs, and tanks.

1.06 CLOSEOUT DOCUMENTS

A. Submit following Closeout Submittals upon completion of the Work and at least 7 days prior to submitting Application for Final Payment:
   1. Evidence of Compliance with Requirements of Governing Authorities.
   2. Project Record Documents.
   3. Operation and Maintenance Manuals.
   4. Warranties and Bonds.
   5. Evidence of Payment and Release of Liens as outlined in Conditions of the Contract.
   6. Release of claims as outlined in Conditions of the Contract.
   7. Survey Record Documents.
   8. Certificate of Final Completion.

1.07 PROJECT RECORD DOCUMENTS

A. Maintain at Project site, available to OWNER and ENGINEER, 1 copy of the Contract Documents, shop drawings and other submittals, in good order:
   1. Mark and record field changes and detailed information contained in submittals and change orders.
   2. Record actual depths, horizontal and vertical location of underground pipes, duct banks and other buried utilities. Reference dimensions to permanent surface features.
   3. Identify specific details of pipe connections, location of existing buried features located during excavation, and the final locations of piping, equipment, electrical conduits, manholes, and pull boxes.
   4. Identify location of spare conduits including beginning, ending and routing through pull boxes, and manholes. Record spare conductors, including number and size, within spare conduits, and filled conduits.
   5. Provide schedules, lists, layout drawings, and wiring diagrams.
   6. Make annotations with erasable colored pencil conforming to the following color code:

Additions:	Red
Deletions:	Green
Comments:	Blue
Dimensions:	Graphite

B. Maintain documents separate from those used for construction:
   1. Label documents "RECORD DOCUMENTS."

C. Keep documents current:
   1. Record required information at the time the material and equipment is installed and before permanently concealing.

D. Deliver record documents with transmittal letter containing date, Project title, CONTRACTOR's name and address, list of documents, and signature of CONTRACTOR.

E. During progress meetings, record documents will be reviewed to ascertain that changes have been recorded.

1.08 WARRANTIES AND BONDS

A. Provide executed Warranty or Guaranty Form if required by Contract Documents.

B. Provide specified additional warranties, guarantees, and bonds from manufacturers and suppliers.

1.09 CERTIFICATE OF FINAL COMPLETION

A. When 7-day operational test has been successfully completed, ENGINEER will certify that new facilities are operationally complete. ENGINEER will submit a list of known items (punch list) still to be completed or corrected prior to contract completion.

B. List of items to be completed or corrected will be amended as items are resolved by CONTRACTOR.

C. When all items have been completed or corrected, submit written certification that the entire work is complete in accordance with the Contract Documents and request final inspection.

D. Upon completion of final inspection, ENGINEER will either prepare a written acceptance of the entire work or advise CONTRACTOR of work not complete. If necessary, inspection procedures will be repeated.

PART 2 PRODUCTS

Not used.

PART 3 EXECUTION

Not used.

END OF SECTION

SECTION 01782

OPERATION AND MAINTENANCE DATA

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Preparation and submittal of operation and maintenance manuals.

1.02 SUBMITTALS

A. Submit operation and maintenance manuals before field quality control testing and before training of each piece of equipment or system.

B. Submit preliminary copies of O&M manuals in accordance with Section 01330.

C. Make additions and revisions to the manuals in accordance with ENGINEER's review comments.

D. Submit 3 copies of approved final manuals for each piece of equipment or system.

E. Make manuals available at project site for use by construction personnel and ENGINEER.

1.03 OPERATION AND MAINTENANCE MANUALS

A. Preparation:
   1. Provide operations and maintenance manuals in 3-ring binders with rigid covers. Utilize tab sheets to organize information.
   2. Provide scanned copy of manual in PDF format with table of sections electronically bookmarked and text searchable.

B. Contents of operation and maintenance manuals:
   1. Cover page: Equipment name, equipment tag number, project name, OWNER's name, appropriate date.
   2. Table of contents: General description of information provided within each tab section.
   3. Equipment description and approved shop drawings submittal, with design criteria and parameters clearly identified.
   4. Lubrication information: Required lubricants and lubrication schedules.
   5. Control diagrams:
      a. Internal and connection wiring, including logic diagrams, wiring diagrams for control panels, ladder logic for computer based systems, and connections between existing systems and new additions, and adjustments such as calibrations and set points for relays, and control or alarm contact settings.
   6. Start-up procedures: Recommendations for installation, adjustment, calibration, and troubleshooting.

7. Operating procedures:
   a. Step-by-step procedures for starting, operating, and stopping equipment under specified modes of operation.
   b. Include safety precautions and emergency operating shutdown instructions.
8. Preventative maintenance procedures: Recommended steps and schedules for maintaining equipment.
9. Overhaul instructions: Directions for disassembly, inspection, repair and reassembly of the equipment; safety precautions; and recommended tolerances, critical bolt torques, and special tools that are required.
10. Parts list: Generic title and identification number of each component part of equipment; include bearing manufacturer, model and ball or roller pass frequencies for every bearing.
11. Spare parts list: Recommended number of parts to be stored at the site and special storage precautions.
12. Drawings: Exploded view or plan and section views with detailed callouts.
13. Provide electrical and instrumentation schematic record drawings.
14. Source (factory) quality control test Results: Provide copies of factory test reports as specified in Sections 15958 or the equipment section.
15. Field quality control test results: After field-testing is completed, insert field test reports as specified in Sections 15958 or the equipment section.
16. Equipment summary form: Completed form in the format attached at the end of this Section. Insert Equipment Summary Form after the tab sheet of each equipment section. The manufacturer's standard form will not be acceptable.

PART 2 PRODUCTS

Not used.

PART 3 EXECUTION

Not used.

END OF SECTION

EQUIPMENT SUMMARY FORM

1. EQUIPMENT ITEM_____

2. MANUFACTURER _____

3. EQUIPMENT IDENTIFICATION NUMBER(S)_____
(maps equipment number)

4. LOCATION OF EQUIPMENT_____

5. WEIGHT OF INDIVIDUAL COMPONENTS (OVER 100 POUNDS)_____

_____

_____

_____

NAMEPLATE DATA -

Horsepower_____
Amperage_____
Voltage_____
Service Factor (S.F.)_____
Speed_____
ENC Type_____
Capacity_____
Other_____

7. MANUFACTURER'S LOCAL REPRESENTATIVE

Name_____

Address_____

Telephone Number_____

8. MAINTENANCE REQUIREMENTS_____

_____

_____

9. LUBRICANT LIST_____

_____

10. SPARE PARTS (recommendations)_____

_____

11. COMMENTS_____

SECTION 01790

SPARE PARTS AND MAINTENANCE

PART 1 GENERAL

1.01 SUMMARY

A. Ninety (90) days after approval of the Shop Drawings of the equipment specified in the individual Sections, the CONTRACTOR shall furnish spare parts data and maintenance material for equipment. The data shall include a complete list of parts and supplies, with current unit prices and source or sources of supply.

B. Spare parts and materials required to be supplied in the Contract Documents shall be furnished in manufacturer's unopened cartons, boxes, crates, or other protective covering suitable for preventing corrosion or deterioration for the maximum length of storage which may be normally anticipated. They shall be clearly marked and identified as to the name of manufacturer or supplier, applicable equipment, part number, description and location in the equipment. All parts shall be protected and packaged for a shelf life of at least 10 years.

C. During construction, store parts in buildings or trailers with floor, roof and closed sides and in accordance with manufacturers' recommendations. Protect from weather, condensation, and humidity.

D. Parts and materials shall be delivered to the OWNER upon Substantial Completion of the Work or start-up. CONTRACTOR shall then place them in permanent storage rooms or areas approved by the OWNER. The turnover procedures shall be developed by the ENGINEER.

E. Provide a letter of transmittal and spare parts receiver form including the following:
   1. Date of letter and transfer of parts and material.
   2. Contract title and number.
   3. CONTRACTOR's name and address.
   4. Transmittal should list applicable specification sections for each set of spare parts supplied.
   5. Spare Parts Receiver Form.

F. CONTRACTOR shall be fully responsible for loss or damage to parts and materials until they are transmitted to the OWNER.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

Not Used.

SPARE PART RECEIVER

Arrowhead Water Reclamation Facility
8180 Union Hills Drive
Glendale, AZ 85310

City of Glendale

CONTRACTOR PLEASE FILL OUT:

MANUFACTURER:_____

ITEM DESCRIPTION:_____

COST:_____

MANUFACTURER PART NUMBER:_____

SUPPLIER:_____

CROSS REFERENCE NUMBER:_____

VENDOR INFORMATION:_____

VENDOR ORDER PART NUMBER:_____

PART TO BE USED ON
WHAT EQUIPMENT:_____

_____

EQUIPMENT NUMBER:_____

SPECIFICATION SECTION:_____

CITY PERSONNEL FILL IN:_____

BIN NUMBER:_____

AIMS NUMBER: _____

LOCATION IN STORES:_____

RECEIVED BY:_____

END OF SECTION

SECTION 01800

POST FINAL INSPECTION

PART 1 GENERAL

1.01 SUMMARY

A. Approximately 330 days after final acceptance, ENGINEER will make arrangements with OWNER and CONTRACTOR for a post final inspection and will send a written notice to said parties informing them of the date and time of the inspection.

B. After the inspection, ENGINEER will inform CONTRACTOR of any corrections required prior to release of the balance of payment due.

C. When the corrections have been satisfactorily completed, ENGINEER will forward to OWNER a certificate for final payment.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

Not Used.

END OF SECTION

SECTION 02050

COMMON WORK RESULTS FOR EARTHWORK

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Aggregate Base Course.
   2. Drain Rock.
   3. Gravel.
   4. Native Material.
   5. Sand.
   6. Select Material.
   7. Stabilization Material.

1.02 REFERENCES

A. ASTM International (ASTM):
   1. C 117 - Standard Test Method for Materials Finer than 75-µm (No. 200) Sieve in Mineral Aggregates by Washing.
   2. C 131 - Standard Test Method for Resistance to Degradation of Small-Size Course Aggregate by Abrasion and Impact in the Los Angeles Machine.
   3. C 136 - Standard Test Method for Sieve Analysis of Fine and Course Aggregates.
   4. D 422 - Standard Test Method for Particle-Size Analysis of Soils.
   5. D 2419 - Standard Test Method for Sand Equivalent Value of Soils and Fine Aggregate.
   6. D 4318 - Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.
   7. D 4829 - Standard Test Method for Expansion Index for Soils.

B. Sponsored and Distributed by the Maricopa Association of Governments - Arizona, 1998 Edition, with updates:
   1. Uniform Standard Specifications for Public Works Construction.

1.03 SUBMITTALS

A. Product data:
   1. Material source.
   2. Gradation.
   3. Testing data.

B. Quality control for aggregate base course:
   1. Test reports: Reports for tests required by Sections of Uniform Standard Specification for Public Works Construction.
   2. Certificates of Compliance: Certificates as required by Sections of Standard Specifications for Public Works Construction.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Storage and protection: Protect from segregation and excessive moisture during delivery, storage, and handling.

PART 2 PRODUCTS

2.01 MATERIALS

A. General:
   1. Provide material having maximum particle size not exceeding 4 inches and that is free of trash, lumber, debris, leaves, grass, roots, stumps, and other organic matter.
   2. Materials derived from processing demolished or removed asphalt concrete are not acceptable.

B. Aggregate base course:
   1. Consist of hard, durable particles or fragments of stone or gravel, screened or crushed to required size and grading and free from vegetable matter, lumps or balls of clay, alkali, adobe, or other deleterious matter.
   2. When sampled and tested in accordance with specified test methods, material shall comply with following requirements:
      a. Durability: Percentage of wear not greater than 40 percent when tested in accordance with ASTM C 131.
      b. Plasticity index: Shall not be more than 5 when tested in accordance with ASTM D 4318.
      c. Liquid limit: Shall not be more than 25 percent when tested in accordance with ASTM D 4318.
   3. Aggregate base course for structures:
      a. Consist of crushed or fragmented particles.
   4. Conform to size and grade within limits as follows when tested in accordance with ASTM C 117 and ASTM C 136:

Sieve Sizes (Square Openings)	Percent by Weight Passing Sieve
1-1/8 inch	100
Number 4	38-65
Number 8	25-60
Number 30	10-40
Number 200	3-12

C. Drain rock:
   1. Consist of hard, durable particles of stone or gravel, screened or crushed to specified size and gradation.
   2. Free from organic matter, lumps or balls of clay, or other deleterious matter.
   3. Crush or waste coarse material and waste fine material as required to meet gradation requirements.
   4. Conform to size and grade within the limits as follows when tested in accordance with ASTM C 117 and C 136:

Sieve Size (Square Openings)	Percent By Weight Passing Sieve
2 inch	100
1-1/2 inch	95-100
3/4 inch	50-100
3/8 inch	15-55
Number 200	0-2

D. Gravel:
   1. Consist of hard, durable particles or fragments of stone or gravel, screened or crushed to specified sizes and gradations.
   2. Free from organic matter, lumps or balls of clay, alkali, adobe, or other deleterious matter.
   3. When sampled and tested in accordance with specified test methods, material shall comply with following requirements:
      a. Durability: Percentage of wear not greater than 40 percent when tested in accordance with ASTM C 131.
      b. Plasticity index: Not greater than 5 when tested in accordance with ASTM D 4318.
      c. Liquid limit: Not greater than 25 percent when tested in accordance with ASTM D 4318.
   4. Conform to sizes and grade within the limits as follows when tested in accordance with ASTM C 117 and C 136:

Sieve Size (Square Openings)	Percent By Weight Passing Sieve	
	Type A	Type B
3 inch	100	--
1-1/2 inch	--	100
Number 4	30 - 75	30 - 70
Number 8	20 - 60	20 - 60
Number 30	10 - 40	10 - 40
Number 200	0 - 12	0 - 12

E. Native material:
   1. Sound, earthen material passing 1-inch sieve.
   2. Percent of material by weight passing Number 200 sieve shall not exceed 30 when tested in accordance with ASTM D 422.
   3. Expansion index less than 35 when tested in accordance with ASTM D 4829.

F. Sand:
   1. Clean, coarse, natural sand.
   2. Nonplastic when tested in accordance with ASTM D 4318.
   3. One hundred percent shall pass a 1/2-inch screen.
   4. No more than 20 percent shall pass a Number 200 sieve.

G. Select material:
   1. Sound earthen material for which sum of plasticity index when tested in accordance with ASTM D 4318 and the percent of material by weight passing Number 200 sieve shall not exceed 23 when tested in accordance with ASTM D 422.
   2. Organic content shall not be greater than 3 percent by volume.

H. Stabilization material:
   1. Consist of clean, hard, durable particles of crushed rock or gravel screened or crushed to the specified sizes and gradations.
   2. Shall be free of any detrimental quantity of soft, friable, thin, elongated, or laminated pieces, disintegrated material, organic matter, oil, alkali, or other deleterious substance.
   3. Shall be free of slaking or decomposition under the action of alternate wetting and drying.
   4. The portion of material retained on the 3/8-inch sieve shall contain at least 50 percent of particles having three or more fractured faces. Not over 5 percent shall be pieces that show no such faces resulting from crushing. Of that portion which passes the 3/8-inch sieve but is retained on the No. 4 sieve, not more than 10 percent shall be pieces that show no faces resulting from crushing.
   5. Conform to size and grade when tested in accordance with ASTM C 117 and ASTM C 136.

Sieve Size (Square Openings)	**Percent by Weight Passing Sieve**
1 inch	100
3/4 inch	90-100
Number 4	0-10
Number 200	0-2

PART 3 EXECUTION

Not Used.

END OF SECTION

SECTION 02300

EARTHWORK

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Loosening, excavating, filling, grading, borrow, hauling, preparing subgrade, compacting in final location, wetting and drying, and operations pertaining to site grading for chemical containment, roads, and other facilities.
   2. Backfilling and compacting under and around structures.

B. Related Sections:
   1. The Contract Documents are complementary; what is called for by one is as binding as if called for by all.
   2. It is the CONTRACTOR's responsibility for scheduling and coordinating the Work of subcontractors, suppliers, and other individuals or entities performing or furnishing any of CONTRACTOR's Work.
   3. The following Sections are related to the Work described in this Section. This list of Related Sections is provided for convenience only and is not intended to excuse or otherwise diminish the duty of the CONTRACTOR to see that the completed Work complies accurately with the Contract Documents.
      a. Section 02050 - Basic Site Materials and Methods.

1.02 REFERENCES

A. ASTM International (ASTM):
   1. D 1556 - Standard Test Method for Density and Unit Weight of Soil in Place by the Sand Cone Method.
   2. D 1557 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft lbf/ft3 (2,700 kN m/m).
   3. D 2922 - Standard Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).
   4. D 3017 - Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth).

B. Maricopa Association of Governments (MAG) - Arizona, with updates through 2010:
   1. Uniform Standard Specifications for Public Works Construction.
      a. Section 201: Clearing and Grubbing.
      b. Section 205: Roadway Excavation.
      c. Section 206: Structure Excavation and Backfill
      d. Section 210: Borrow Excavation.
      e. Section 211: Fill Construction.
      f. Section 215: Earthwork for Open Channels.
      g. Section 225: Watering.
      h. Section 425: Topsoils.

1.03 DEFINITIONS

A. Backfill adjacent to structure: Backfill within volume bounded by the exterior surfaces of structure, the surface of undisturbed soil in the excavation around structure, and finish grade around structure.

B. Structural fill: Classified fill placed under/below structures extending beyond the edges of the structure as shown on the plans or where not specified, a distance beyond the edge a distance equal to/or greater than depth of fill.

C. Excavation: Consists of loosening, removing, loading, transporting, depositing, and compacting in final location, wet and dry materials, necessary to be removed for purposes of construction of structures, ditches, grading, roads, and such other purposes.

1.04 SYSTEM DESCRIPTION

A. Performance requirements:
   1. Where mud or other soft or unstable material is encountered, remove such material and refill space with stabilization material. Wrap stabilization material with stabilization fabric.
   2. Obtain acceptable import material from other sources if excavated or borrow materials obtained within Project site do not conform to specified requirements or are not sufficient in quantity.
   3. No extra compensation will be made for hauling of fill materials nor for water required for compaction.

1.05 SUBMITTALS

A. Copy of property owner's agreement allowing excavation of borrow materials or placement of surplus soil material from or onto their property. If borrow material is obtained from a commercial source submit name and location of commercial source.

B. Excavation plan.

C. Submit test reports to ENGINEER for approval for any imported borrow or other material obtained outside of the limits of the Project Site.

D. Testing lab: Submit CONTRACTOR's proposed testing laboratory. Laboratory shall be certified and approved by the Arizona Department of Transportation.

E. Test reports: Submit certified test reports of all tests specified to be performed by the CONTRACTOR, including failing tests and retests of failed areas. Submit draft reports or test results within one week of the applicable test. Final test reports shall be signed and sealed by a registered Engineer who practices geotechnical engineering registered in Arizona.

1.06 QUALITY ASSURANCE

A. Initial compaction demonstration:
   1. Adequacy of compaction equipment and procedures: Demonstrate adequacy of compaction equipment and procedures before exceeding any of following amounts of earthwork quantities:
      a. Fifty cubic yards of structural fill or backfill adjacent to structures.
      b. One hundred cubic yards of embankment work.
      c. One hundred cubic yards of common borrow fill.
      d. Fifty cubic yards of roadway base material.
      e. One hundred cubic yards of road fill.
   2. Compaction sequence requirements: Until specified degree of compaction on previously specified amounts of earthwork is achieved, do not perform additional earthwork of the same kind.
   3. After satisfactory conclusion of initial compaction demonstration and at any time during construction, provide confirmation tests as specified under "FIELD QUALITY CONTROL."

1.07 SEQUENCING AND SCHEDULING

A. Schedule earthwork operations to meet requirements in this Section for excavation and uses of excavated material.

B. If necessary, stockpile excavated material in order to use it at specified locations.

C. Excavation, backfilling, and filling: Perform excavation, backfilling, and filling during construction in manner and sequence that provides drainage at all times.

D. Conform to the requirements of the Stormwater Pollution Prevention Plan (SWPPP).

PART 2 PRODUCTS

2.01 MATERIALS

A. Water for compacting: Use water from source acceptable to ENGINEER.

B. Soil and rock materials:
   1. General:
      a. Provide aggregate base course drain rock, gravel, native material, sand, select material, and stabilization material where specified or indicated on the Drawings.
      b. If suitable surplus materials are available, obtain native material from cut sections or excavations, including excavation for adjacent Recharge Basin.
   2. Aggregate base course materials: As specified in Section 02050.
   3. Native material or unclassified common borrow: As specified in Section 02050.
   4. Select structural fill material for engineered fill: Select material obtained from onsite or basins as specified in Section 02050 (Structural Fill). Imported borrow or lime or cement stabilization may need to be obtained for engineered fill if sufficient acceptable untreated material cannot be obtained onsite.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verification of conditions:
   1. Character and quantity of material:
      a. Verify character and quantity of rock, gravel, sand, silt, water, and other inorganic or organic materials to be encountered in work to be performed.
      b. Determine gradation and shrinkage, and swelling of soil, and suitability of material for use intended in work to be performed.
      c. Determine quantity of material, and cost thereof, required for construction of backfills, cuts, embankments, excavations, fills, and roadway fills, whether from onsite excavations, or imported materials. Include in cost of work to be performed.
      d. Include wasting of excess material, if required, in cost of work to be performed. Excess material may be placed near to or within the Project Limits as specified and approved in the field by the ENGINEER.

B. Verify the requirements of the Storm Water Pollution Prevention Plan.

3.02 PREPARATION

A. SWPPP:
   1. Ensure that necessary pollution prevention measures are in place prior to commencing operations.

B. Clearing and grubbing:
   1. Remove existing topsoil and organic material not suitable for embankment fill as determined by the ENGINEER. Stockpile material for reuse onsite.
   2. Conform Sections 201, 205, and 425 of the current MAG Standard Specifications.
   3. Conform to the requirements of Section 02200.
   4. Due to the disturbance of the surface soils, at least the upper 12 inches of the surface in general yard and roadway areas shall be over-excavated and recompacted. For structures, the over-excavation is shown on the Drawings.

C. Backfills:
   1. After clearing and excavation are completed, scarify entire areas which underlie backfills or structures to a depth of 8 inches, unless shown otherwise on the Drawings, and until surface is free of ruts, hummocks, and other features which would prevent uniform compaction by equipment to be used. Moisture condition to optimum moisture content +/- 2 percent.
   2. Recompact scarified areas to density specified before placing backfill material or concrete.
   3. No backfill shall be placed against walls until:
      a. Walls have been cast full height of structure and concrete has reached the specified strength.
      b. Connecting slabs and beams have been cast and concrete has reached the specified strength.
   4. Prior to backfilling, all forms shall be removed and the excavation shall be cleaned of all trash and debris.

5. After inspection of foundation, walls, and pipes, backfill shall be placed symmetrically around structures to prevent eccentric loading of structures.
6. Conform to Sections 201, and 206 of the current MAG Standard Specifications.
7. Conform to the requirements of the Drawings.

D. Embankments and structural fills:
1. After clearing is completed and over-excavation of unsuitable materials is completed to the depths specified, scarify entire areas which underlie embankments to a depth of 8 inches, unless shown otherwise on the Drawings, and until surface is free of ruts, hummocks, and other features which would prevent uniform compaction by equipment to be used. Moisture condition to optimum moisture content +/- 2 percent.
2. Recompact scarified areas to density specified for embankments before placing of embankment material.
3. Conform to Sections 201, and 211 of the current MAG Standard Specifications.
4. Conform to the requirements of the Drawings.

3.03 INSTALLATION

A. General:
1. Dispose of excavated materials which are not required or are unsuitable for fill and backfill in lawful manner.
2. Dispose of surplus material on private property only when written permission agreement is furnished by owner of property. Submit copies of such agreements.
3. Rocks, broken concrete, or other solid materials larger than 4 inches in greatest dimension shall not be placed, but shall be removed from project site at no additional cost to OWNER.
4. Stabilization of Subgrade: Provide materials used, or perform work required, to stabilize subgrade so it can withstand loads which may be placed upon it by CONTRACTOR's equipment.
5. Conform to Sections 201, and 206 of the current MAG Standard Specifications.
6. Conform to the requirements of the Drawings.

B. Compaction:
1. Provide specified compaction for backfills, cuts, embankments, fills, roadway fills, and other earthwork.
2. Perform confirmation tests to verify and confirm that work has complied, and is complying at all times, with compaction requirements specified in this Section for initial compaction demonstration and field quality control testing.
3. In-place density of compacted backfills, cuts, fills, and roadway fills determined in accordance with ASTM D 1556, or with ASTM D 2922 and ASTM D 3017.
4. Maximum density obtained in laboratory when tested in accordance with ASTM D 1557.
5. To prevent damage to structures due to backfilling operations, backfill shall be placed with equipment that does not place undue loading, as determined by the ENGINEER, within a distance from the face of the structure of not less than 1/2 the depth of backfill. The depth of backfill is the distance between the

level being compacted and the bottom of the excavation. Outside this distance, heavier compaction equipment may be used.

6. Compact to percentage of maximum density as follows:
   a. Conform to the additional requirements of the Drawings, but not less than the following:

A.	Building areas:	
	1. Below footing level.	95
	2. Below slabs-on-grade (non-expansive soils).	90
	3. Deep fills (more than 2.5 feet of engineered fill).	97
B.	Pavement subgrade or fill.	95
C.	Utility trench backfill:	
	1. More than 2.0 ft. below finish subgrade.	90
	2. Within 2.0 ft. of finish subgrade (non-granular).	95
	3. Within 2.0 ft. of finish subgrade (granular).	95
D.	Aggregate base course:	
	1. Below floor slabs.	95
	2. Below asphalt paving.	95
E.	Landscape areas:	
	1. Miscellaneous fill.	85
	2. Utility trench - more than 1.0 ft. below finish grade.	80
	3. Utility trench - within 1.0 ft. of finish grade.	85

C. Excavation:
   1. Blasting shall not be permitted.
   2. Excavations for structures:
      a. Provide excavations conforming to dimensions and elevations indicated on the Drawings for each structure, including trenching for piping and all work incidental thereto.
      b. After clearing is complete, excavate for the structure, down to the elevation indicated on the Drawings. Unless directed by ENGINEER, excavations shall not be carried below elevation indicated on the Drawings.
      c. Where soil is encountered having unsuitable bearing value, ENGINEER may direct in writing that excavation be carried to elevations below those indicated on the Drawings.
      d. Where excavations are made below elevations indicated on the Drawings, adjust elevations of excavations in accordance with the following requirements:
         1) Under slabs: Restore to proper elevation in accordance with procedure specified for backfill in this Section and on Drawings.
         2) Under footings: Restore to the proper elevation as specified in the Drawings and Section 02050.
      e. Excavation width:
         1) Extend excavations at least 2 feet clear from walls and foundations of structures to allow for placing and removal of forms, installation of services, and inspection.
         2) Do not undercut slopes.

f. Difficulty of excavation: No extra compensation will be made for removal of rock or any other material due to difficulty of excavation.
g. Conform to Section 206 of the MAG Standard Specifications.
h. Test borings in the Speedie Reports may be reviewed to estimate difficulty of excavation; but no additional payment will be made for difficult excavation.

3. Excavation of ditches:
   a. Cut ditches accurately to cross sections and grades indicated on the Drawings.
   b. Take care not to excavate ditches below grades indicated on the Drawings.
   c. Backfill excessive ditch excavations to grade with suitable material acceptable to ENGINEER that is thoroughly compacted.
   d. Do not deposit any material within 3 feet of edge of ditch unless otherwise indicated on the Drawings.
   e. Conform to Sections 205, 210 and 215 of the MAG Standard Specifications.
   f. Conform to the requirements of the Drawings.
4. Necessary over excavation:
   a. Where it becomes necessary to excavate beyond normal lines of excavation in order to remove boulders or other interfering objects, backfill voids remaining after removal as specified in backfilling of voids below, or as acceptable to the ENGINEER.
   b. Backfill voids with material acceptable to the ENGINEER.

D. Materials for backfills, , roadway fills:
1. General:
   a. Obtain import material from other sources if surplus materials from cuts and excavations obtained from within Project site do not conform to specified requirements or are not sufficient in quantity for construction of Project.
2. Backfills:
   a. Material for backfill adjacent to structures, slabs, or walls shall conform to the requirements of the Drawings and Section 02050 for structural fill.
   b. Structural fill material under concrete structures shall conform to the requirements of the Drawings. Backfill in any area under concrete structures shall extend from undisturbed soil or rock to the bottom aggregate base course material layer, unless shown otherwise on the Drawings.
   c. Clayey soils classified as SC or CL are considered "expansive soils" and should not be used as backfill, except where specified where shown on the Drawings as a sealing layer for prevent water from entering the fill.

E. Placement:
1. General:
   a. Lines and grades:
      1) Construct backfills, embankments, fills, and road fills, at locations and to lines and grades indicated on the Drawings.
      2) All permanent fill slopes shall be overbuilt by at least 1 foot and then cut to final grade to provide adequate compaction of the remaining fill.

2. Backfills:
   a. Place loose material in successive layers that do not exceed 8 inches in depth after compaction.
   b. Bring each layer to optimum moisture content plus or minus 2 percent before compacting.
   c. Defective backfills: Remove and recompact.
   d. Conform to Section 206, 211 and 225 of the MAG Standard Specifications.
   e. Conform to the requirements of the available geotechnical reports.

F. SWPPP:
   1. Maintain all necessary pollution prevention measures during the course of the project.

3.04 FIELD QUALITY CONTROL

A. Tests:
   1. Confirmation tests:
      a. CONTRACTOR's responsibilities:
         1) Accomplish specified compaction for backfills, fills, and other earthwork.
         2) Control operations by confirmation tests to verify that compaction work complies, and is complying at all times, with requirements specified in this Section concerning compaction, control, and testing.
         3) Cost of confirmation tests: Paid for by the CONTRACTOR.
         4) Qualifications of CONTRACTOR's testing laboratory: Laboratory shall be certified and approved by the Arizona Department of Transportation.
         5) Test reports: Submit certified test reports of all tests specified to be performed by the CONTRACTOR, including failing tests and retests of failed areas. Submit draft reports or test results within one week of the applicable test. Final test reports shall be signed and sealed by a registered engineer who practices geotechnical engineering registered in Arizona.
      b. Frequency of confirmation testing:
         1) The following to be determined by the ENGINEER:
         2) Perform testing not less than the following:
            a) In-place density:
               (1) Structural Fill and Backfill: 1 every 50 c.y.
               (2) General Fills: 1 every 200 c.y.
               (3) Roadway Fills: 1 every 100 c.y.
            b) Maximum dry density versus moisture: Per paragraph 3.03 of this Specification.
   2. Compliance tests:
      a. Periodic compliance tests will be made by the ENGINEER to verify that compaction is meeting requirements previously specified.
      b. Remove overburden above level at which the ENGINEER wishes to test. Backfill and recompact excavation after testing is completed.
      c. If compaction fails to meet specified requirements, perform remedial work by one of the following methods:
         1) Remove and replace materials at proper density.

2) Bring density up to specified level by other means acceptable to the ENGINEER.

d. Retesting:
   1) Costs of retesting required to confirm and verify that remedial work has brought compaction within specified requirements shall be borne by the CONTRACTOR.
   2) CONTRACTOR's confirmation tests during performance of remedial work: Double the normal rate specified herein.

B. Tolerances:
   1. Finish grading of backfills, cuts, and fills:
      a. Perform fine grading under concrete structures such that finish surfaces are never above the grade or cross section indicated on the Drawings and are never more than 0.10 feet below.
      b. Provide finish surface for areas outside of structures that are within 0.10 feet of grade or cross section indicated on the Drawings.
   2. Areas which are not under structures, concrete, asphalt, roads, pavements, sidewalks, dikes, and similar facilities:
      a. Provide finish graded surfaces of either undisturbed soil, or cohesive material not less than 6 inches deep.
      b. Intent of proceeding is to avoid sandy or gravelly areas.
   3. Finish grading of surfaces:
      a. Reasonably smooth, compacted, and free from irregular surface changes.
      b. Provide degree of finish that is ordinarily obtainable from blade grader operations, except as otherwise specified.
      c. Uniformly grade areas which are not under concrete.
      d. Finish ditches and gutters so that they drain readily.

3.05 ADJUSTING

A. Finish grades of excavations, backfills, and fills:
   1. Repair and reestablish grades to required elevations and slopes due to any settlement or erosion that may occur from action of the elements or any other cause prior to final acceptance.

3.06 PROTECTION

A. Finish grades of backfills, cuts, excavations, and fills:
   1. Protect newly graded areas from erosion and deterioration by action of the elements.

B. Ditches and gutters:
   1. Maintain ditches and gutters free from detrimental quantities of debris that might inhibit drainage until final acceptance.

END OF SECTION

SECTION 02318

TRENCHING

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes: Trench excavation, fine grading, pipe bedding, backfilling, and compaction for the following, including requirements for ditch crossings:
   1. Pipe and electrical conduits.
   2. Manholes, valves, or other accessories.
   3. Potable water pipe appurtenances.

1.02 REFERENCES

A. ASTM International (ASTM):
   1. D 698 - Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbF/ft^3).
   2. D 1556 - Test Method for Density of Soil in Place by the Sand-Cone Method.
   3. D 1557 - Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft. lbF/ft^3).
   4. D 2922 - Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).
   5. D 3017 - Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth).

1.03 SUBMITTALS

A. Products Data:
   1. For all proposed bedding and backfill materials:
      a. Material source.
      b. Gradation.
      c. Testing data and testing lab qualifications including lab certification.
   2. For conductive tracer tape.

PART 2 PRODUCTS

2.01 MATERIALS

A. General:
   1. Provide material having maximum particle size not exceeding 4 inches and that is free of leaves, grass, roots, stumps, and other vegetable matter.
   2. Materials derived from processing demolished or removed asphalt concrete are not acceptable.

B. Aggregate Base Course: As specified in Section 02050.

C. Gravel: As specified in Section 02300.

D. Native Material: As specified in Section 02300.

E. Sand: As specified in Section 02300.

F. Select Material: As specified in Section 02300.

G. Conductive Tracer Tape:
   1. Polyethylene plastic jacketed, metallic foil tape:
      a. Minimum thickness - 5.0 mils.
      b. Width - 6 inches.
   2. Color coated and printed with warning of applicable buried utility line below.

PART 3 EXECUTION

3.01 PREPARATION

A. General:
   1. Trench Condition:
      a. Install pipe and materials as specified herein.
   2. Embankment Condition:
      a. Exists where width of trench exceeds limits specified herein.
      b. Before laying pipes or electrical conduits in fill, place fill and compact it to not less than 2 feet above top of pipe or conduit.
      c. After placing and compacting fill, excavate through fill and fine grade as required in this Section.

3.02 INSTALLATION

A. Trench Excavation:
   1. General Requirements:
      a. If, because of soil conditions, safety requirements or other reasons, trench width at top of pipe is increased beyond width specified in this Section, upgrade laying conditions or install stronger pipe designed in conformance with Specifications for increased trench width, without additional cost.
      b. In-place density determined in accordance with ASTM D 1556, or with ASTM D 2922 and ASTM D 3017.
      c.
      d. Pipe and Electrical Conduits:
         1) Lay pipe and electrical conduits in open trench.
         2) If bottom of excavation is found to consist of rock or any material that by reason of its hardness cannot be excavated to provide uniform bearing surface, remove such rock or other material to a depth of not less than 4 inches below bottom of pipe and refill to grade with aggregate base course material or sand placed at uniform density, with minimum possible compaction, at no additional cost.
         3) If bottom of excavation is found to consist of soft or unstable material which is incapable of properly supporting pipe, remove such material to a depth and for the length required, as determined by the

ENGINEER, and then refill trench to grade with aggregate base course or sand, compacted to 90 percent of maximum density.

4) Where indicated on the Drawings, cradle pipe in concrete.
5) Minimum Clear Width of Trench for Pipe (Measured at Top of Pipe):
   a) Not less than outside diameter of pipe plus 18 inches.
6) Maximum Clear Width of Trench for Pipe (Measured at Top of Pipe):
   a) Not to exceed outside diameter of pipe plus 24 inches.

e. For Manholes, Valves, or Other Accessories:
   1) Provide excavations sufficient to leave at least 12 inches clear between their outer surfaces and embankment or shoring which may be used to hold banks and protect them.
   2) Do not backfill with earth under manholes, vaults, tanks, or valves.
   3) Fill any unauthorized excess excavation below elevation indicated on the Drawings for foundation of any structure with sand, aggregate base material, bedding material, or concrete at no additional cost.
   4) Backfilling of Manhole Excavation: Conform to backfilling requirements as specified for trenches in this Section.
f. Potable Water Pipe Appurtenances:
   1) Lay in trenches separate from those used for sewers.
   2) Unless otherwise specified or indicated on the Drawings, lay in trenches having cover of not less than 3 feet below surface of ground and located at distance of not less than 10 feet from any parallel sewer trench.
g. At Road Crossings or Existing Driveways:
   1) Make provision for trench crossings at these points, either by means of backfills, tunnels, or temporary bridges.

B. Trench Fine Grading:
   1. Fine grading material shall be as scheduled herein.
      a. Unless otherwise specified, accurately grade bottom of trench to provide uniform bearing and support for each section of pipe, on undisturbed soil at every point along pipe's entire length, except for portions of pipe where it is necessary to excavate for bells and for proper sealing of pipe joints.
   2. Bell or Coupling Holes:
      a. Dig holes after trench bottom has been graded.
      b. Provide holes of sufficient width to provide ample room for grouting, banding, or welding.
      c. Excavate holes only as necessary in making joints and to ensure that pipe rests upon prepared trench bottom and not supported by any portion of the joint.
   3. Depressions for Joints, Other than Bell-and-Spigot:
      a. Make in accordance with recommendations of joint manufacturer for particular joint used.

C. Pipe Bedding:
   1. Bedding material shall be as scheduled herein.
   2. After Pipe Laid:
      a. Place bedding material under and around pipe to level even with spring line of pipe, and compact to 95 percent of maximum density.
      b. Fill section of trench from spring line to 12 inches above top of pipe with bedding material and water settle or mechanically compact to 95 percent of maximum density.

3. Pipe Displacement:
    a. Take necessary precautions in placement and compaction of bedding material to prevent displacement of piping.
    b. In event there is movement or floating, re-excavate re-lay, and backfill the pipe.
4. Consolidation:
    a. When acceptable to the ENGINEER, perform consolidation by flooding and poling, or jetting so as to obtain compaction of backfill material at least equal to that specified.
    b. Do not use water settling methods when backfill material is not sufficiently granular in nature to be self-draining during and after consolidation and when foundation materials may be softened or otherwise damaged by water.
    c. When flooding, poling, or jetting methods are used, place and consolidate material used as backfill in layers not exceeding 4 feet in thickness.
    d. Supplement flooding and poling, or jetting methods by use of vibratory or other compaction equipment when necessary to obtain required compaction.
5. Pipe Bedding for PVC Piping or Other Flexible Type Piping:
    a. Lay piping in a sand embedment:
        1) For single pipe: A minimum of 4 inches of sand below and above the pipe and a minimum of 6 inches of sand on each side.
        2) For multiple pipes: A minimum of 4 inches of sand below and above the largest sized pipe, a minimum of 3 inches of sand between pipes, and a minimum of 6 inches of sand on the sides of the outer pipes.
    b. Compact sand embedment to a uniform density.
    c. Above the sand embedment, place and compact to 90 percent maximum density a 12 inch layer of aggregate base course material.

D. Trench Backfill:
1. Place and compact backfill in accordance with following requirements:
    a. From 12 inches above top of pipe to natural surface level.
    b. Finish grade indicated on the Drawings as follows:
        1) Backfill for trench cuts across roadways and paved streets:
            a) Backfill trench to underside of specified pavement replacement with aggregate base course material compacted to 95 percent of maximum density.
        2) Trench backfill for longitudinal trench cuts in roadways, paved areas, and storage areas:
            a) Backfill trench up to within 2 feet of finish grade with native material compacted to 95 percent of maximum density.
            b) Then backfill from 2 feet below finish grade to finish grade, or to underside of specified aggregate base course material as indicated on the Drawings, or to underside of specified pavement replacement with native material, aggregate base course material, or select material compacted to 95 percent of maximum density.
    c. Trench backfill for trench cuts in areas outside the improved section of roadways and in open country: Backfill trench from 12 inches above top of pipe to finish grade with native material compacted to 95 percent of maximum density.

d. Trench backfill through earth slopes or embankments supporting structures, through structural fill, or adjacent to and/or under structures: Backfill trench from 12 inches above top of pipe to finish grade with ABC material or approved select material compacted to 95 percent of maximum density.
e. Existing conditions: Where existing underground pipes or conduits larger than 3 inches in diameter cross trenches above new work:
1) Backfill from bottom of trench to spring line of intersecting pipe or conduit with aggregate base course material compacted to 95 percent of maximum density when tested in accordance with ASTM D 1556 or ASTM D 2922.
2) Extend aggregate base course material 2 feet on either side of intersecting pipe or conduit to ensure that material remains in place while other backfill is placed.
3) Backfill remainder of trench according to Paragraph D, above.

E. Compacting Native Material:
1. Assure that native material, when used as previously specified, is capable of being compacted to degree specified.
2. If native material cannot be compacted to density as previously specified, remove and dispose of material whether it has been placed in trench as backfill or not, and utilize other backfill material from another source acceptable to the ENGINEER.

F. Excess Material:
1. Remove excess excavated material from the project site per the ENGINEERS direction and dispose of legally off site.

G. Conductive Tracer Tape:
1. Install over all new plastic pipe lines.
2. Bury directly above pipeline along the entire alignment, 18 inches below grade.

3.03 FIELD QUALITY CONTROL

A. Tests:
1. Confirmation Tests:
a. CONTRACTOR's Responsibilities:
1) Accomplish specified compaction of trench backfill.
2) Control operations by confirmation tests to verify and confirm that compaction work complies, and is complying at all times, with requirements specified in this Section concerning compaction, control, and testing.
3) Cost of confirmation tests: Paid for by the CONTRACTOR.
4) Qualifications of CONTRACTOR's testing laboratory: Provide lab certification.
5) Copies of confirmation test reports: Submit promptly to the ENGINEER.
b. Frequency of Confirmation Testing:
1) Perform testing not less than as follows:
a) For trenches: At each test location include tests for each type or class of backfill from bedding to finish grade.
b) In open fields: 2 every 1,000 linear feet.

c) Along dirt or gravel road or off traveled right-of-way: Two every 500 linear feet.
d) Crossing paved roads: 2 locations along each crossing.
e) Under pavement cuts or within 2 feet of pavement edges: 1 location every 400 linear feet.

2. Compliance Tests:
   a. Frequency of testing: Periodic compliance tests will be made by the ENGINEER to verify that compaction is meeting requirements previously specified.
   b. For tests in water settled backfill: Remove overburden above level at which the ENGINEER wishes to test. Backfill and recompact excavation after testing is completed.
   c. If compaction fails to meet specified requirements: Perform remedial work by one of the following methods:
      1) Remove and replace backfill at proper density.
      2) Bring density up to specified level by other means acceptable to the ENGINEER.
   d. Retesting:
      1) Costs of retesting: Costs of retesting required to confirm and verify that remedial work has brought compaction within specified requirements shall be borne by the CONTRACTOR.
      2) CONTRACTOR's confirmation tests during performance of remedial work:
         a) Performance: Perform tests in manner acceptable to the ENGINEER.
         b) Frequency: Double amount specified for initial confirmation tests.
3. Water Testing Pipe:
   a. After bedding the pipe, CONTRACTOR has the following option to:
      1) Water-test pipe.
      2) Backfill to surface, at his own risk, before water-testing pipe.
   b. If pipe does not pass test, uncover pipe, locate leaks, repair and retest, repeating until pipe section under test passes.

3.04 SCHEDULES

A. Fine Grading Materials:
   1. Where required, fine grading material shall be the same as bedding material.

B. Bedding Materials:
   1. For pipe less than 16-inch nominal size: Except as otherwise specified, use sand or aggregate base course.
   2. For polyvinyl chloride or other plastic pipe: Sand or select material.

C. Backfill Materials:
   1. Aggregate base course or approved native or select material.

END OF SECTION

SECTION 02742

ASPHALTIC CONCRETE PAVING

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes: Asphalt concrete pavement on prepared subgrade or aggregate base course, and on existing pavement, to lines, grades, compacted thicknesses, and cross sections indicated on the Drawings.

B. Related Sections:
   1. 02300 - Earthwork.
   2. 02722 - Aggregate Base Course.

1.02 REFERENCES

A. American Association of State Highway and Transportation Officials (AASHTO):
   1. Standard Specifications for Transportation Materials and Methods of Sampling and Testing:
      a. MP1: Specification for Performance Graded Asphalt Binder.
      b. T -245: Standard Method of Test for Resistance to Plastic Flow of Bituminous Mixtures Using Marshall Apparatus.

B. ASTM International (ASTM):
   1. C 117 - Standard Test Method for Material Finer than 75 FM (No. 200) Sieve in Mineral Aggregates by Washing.
   2. C 131 - Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.
   3. C 136 - Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
   4. D 977 - Standard Specification for Emulsified Asphalt.D 4318 - Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.

C. The Asphalt Institute:
   1. Manual MS-2 "Mix Design Methods for Asphalt Concrete.

D. Maricopa Association of Governments (MAG) - Arizona, 1998 Edition, with updates through 2007:
   1. Uniform Standard Specifications for Public Works Construction:
      a. Section 321: Asphalt Concrete Pavement.
      b. Section 333: Fog Seal Coats.
      c. Section 702: Rock, Gravel and Sand.
      d. Section 710: Asphalt Concrete.
      e. Section 711: Paving Asphalt.
      f. Section 713: Emulsified Asphalt.

1.03 SYSTEM DESCRIPTION

A. Performance Requirements:
   1. Compact the asphalt concrete to at least 95 percent of the density of the laboratory specimen of the same mixture subjected to 75 blows of a standard Marshall hammer test in accordance with ASTM D 1559.

1.04 SUBMITTALS

A. Proposed mix design and gradation of materials.

B. Quality Control Submittals:
   1. Certificate of Compliance.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Conform to Section 710 of the MAG Standard Specifications.

1.06 PROJECT CONDITIONS

A. Environmental Requirements:
   1. Asphalt Concrete:
      a. Conform to Section 321 of the MAG Standard Specifications.

PART 2 PRODUCTS

2.01 MATERIALS

A. Prime Coat:
   1. Not Used.

B. Sand:
   1. Acceptable to the ENGINEER.

C. Tack Coat:
   1. SS-1 h. Conform to Section 713 of the MAG Standard Specifications.

D. Asphalt Cement:
   1. Performance Grade PG 76-10. Conform to Section 711 of the MAG Standard Specifications.

E. Asphalt Concrete:
   1. Conform to Section 710 of the MAG Standard Specifications and City of Glendale Guidelines.
   2. 19 mm Surface Course. 75 blow (high traffic) Marshall Mix Design in accordance with Table 710-5.

2.02 EQUIPMENT

A. Conform to Section 321 of the MAG Standard Specifications for placement, spreading and compacting

B. Conform to Section 710 of the MAG Standard Specifications of Asphalt Plant and plant operations.

PART 3 EXECUTION

3.01 SUBGRADE PREPARATION

A. Conform to MAG Section 301, with the exception that all areas to receive pavement shall be compacted to a relative compaction or 95 percent.

3.02 PLACEMENT, SPREADING AND FINISHING

A. Conform to MAG Section 321.

3.03 FIELD QUALITY CONTROL

A. Placement:
   1. Place the mixture on the roads, pavements, or walks within the temperature range specified in the mix design.

B. Tests:
   1. Provide sampling and control testing for the asphalt concrete. The CONTRACTOR shall engage a testing laboratory accredited by the AASHTO Materials Reference Laboratory, or an equivalent certification agency for AASHTO Method T 166.
   2. The type and size of the samples shall be suitable to determine conformance with stability, density, thickness and other specified requirements. Use an approved power saw or core drill for cutting samples. Furnish all tools, labor, and materials for cutting samples, testing, and replacing the pavement where samples were removed. Take a minimum 1 sample per 200 tons of asphalt concrete placed. The ENGINEER may direct the CONTRACTOR to take additional samples at locations specified by the ENGINEER.
   3. All results of sampling and testing shall be delivered directly from the testing laboratory to the ENGINEER within seven days of completion of preliminary test results.

C. Inspection:
   1. Asphalt Concrete: When tested with a 10-foot 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 inch.

END OF SECTION

SECTION 02952

PAVEMENT RESTORATION AND REHABILITATION

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Resurfacing roads and paved surfaces in which surface is removed or damaged by installation of new work.

1.02 SYSTEM DESCRIPTION

A. Performance Requirements:
   1. Limiting Dimensions:
      a. Determine the exact lengths and dimensions of such roads, pavements, parking areas, and walks that will require removal and replacement for new work.
      b. Join existing surfaces to terminals of new surfacing in smooth juncture.

1.03 SUBMITTALS

A. Mix Designs:
   1. Prior to placement of asphalt concrete, submit full details, including design and calculations for the asphalt concrete mix proposed.
   2. Submit gradation of aggregate base.
   3. Submit proposed mix design of portland cement concrete.

PART 2 PRODUCTS

2.01 MATERIALS

A. Aggregate Base Course: As specified in Section 02050.

B. Asphalt Pavement: As specified in Section 02742.

C. Portland Cement Concrete Replacement Material: Class A concrete as specified in Section 03300.

2.02 EQUIPMENT

A. Roads, Pavements, Parking Areas, and Walks:
   1. Equipment Requirements: Good condition, capable of performing work intended in satisfactory manner.

2.03 ACCESSORIES

A. Material for Painting Asphalt Concrete Pavement: Tack coat as specified in Section 02742.

PART 3 EXECUTION

3.01 INSTALLATION

A. Aggregate Surface Removal Replacement:
   1. When trench cut is in aggregate surfaced areas, replace aggregate base course material with material matching existing material compacted to 95 percent of its maximum density.

B. Pavement Removal and Temporary Asphalt Replacement:
   1. Install temporary asphalt pavement or first course of permanent pavement replacement immediately following backfilling and compaction of trenches that have been cut through existing pavement.
   2. Except as otherwise provided, maintain this temporary pavement in safe and reasonably smooth condition until required permanent pavement is installed.
   3. Remove and dispose of temporary paving from project site.
   4. Where longitudinal trench is partly in pavement, replace pavement to original pavement edge, on a straight line, parallel to center line of roadway.
   5. Where no part of longitudinal trench is in pavement, surfacing replacement shall only be required where existing surfacing materials have been removed.

C. Asphalt Pavement Replacement:
   1. Replace asphalt pavement to same thickness as adjacent pavement and match as nearly as possible adjacent pavement in texture, unless otherwise indicated on the Drawings.
   2. Cut existing asphalt pavements to be removed for trenches or other underground construction by wheel cutter, clay spade, or other device capable of making neat, reasonably straight and smooth cut without damaging adjacent pavement. Cutting device operation shall be subject to acceptance of ENGINEER.
   3. Cut and trim existing pavement after placement of required aggregate base course and just prior to placement of asphalt concrete for pavement replacement, and paint trimmed edges with material for painting asphalt concrete pavement immediately prior to constructing new abutting asphalt pavements. No extra payment will be made for these items, and all costs incurred in performing this work shall be incidental to pipe laying or pavement replacement.
   4. Conform replacement of asphalt pavement to contour of original pavement.

D. Portland Cement Concrete Pavement Replacement:
   1. Where trenches lie within Portland cement concrete section of streets, alleys, sidewalks, and similar concrete construction, saw cut such concrete (to a depth of not less than 1-1/2 inches) to neat, vertical, true lines in such manner adjoining surfaces are not damaged.
   2. Place portland cement concrete replacement material to dimension as indicated on the Drawings.

3. Provide expansion joints that match existing.
4. Before placing replacement concrete, thoroughly clean edges of existing pavement and wash with neat cement and water.
5. Surface Finish: Wood float finish.

E. Curb, Gutter, and Sidewalk Replacement:
1. Where any concrete curb, gutter, or sidewalk has been removed or displaced, replace to nearest construction joints with new Class A curb, gutter, or sidewalk to same dimensions and finish as original construction that was removed.
   a. Provide expansion joints of same spacing and thickness as original construction.

F. Trim existing asphalt pavements which are to be matched by pavement widening or pavement extension to neat true line with straight vertical edges free from irregularities with saw specifically designed for this purpose. Minimum allowable depth of cut shall be 1-1/2 inches.

G. Cut and trim existing pavement after placement of required aggregate base course and just prior to placement of asphalt concrete for pavement widening or extension, and paint trimmed edges with material for painting asphalt concrete pavement immediately prior to constructing new abutting asphalt concrete pavements. No extra payment will be made for these items and all costs incurred in performing this work shall be incidental to widening or pavement extension.

3.02 FIELD QUALITY CONTROL

A. Tests:
1. Asphalt concrete as specified in Section 02722.
2. Concrete as specified in Section 03300.

B. Inspection:
1. Asphalt Concrete:
   a. Lay 10 foot straightedge parallel to center line of trench when the trenches run parallel to street, and across pavement replacement when trench crosses street at angle.
   b. Remove and correct any deviation in cut pavement replacement greater than 1/4 inch in 10 feet.
2. Portland Cement Concrete Replacement Pavement:
   a. Lay 10 foot straightedge either across pavement replacement or longitudinal with center line of gutter or ditch.
   b. Remove and correct any deviation in cut pavement replacement greater than 1/4 inch in 10 feet.

END OF SECTION

SECTION 03055

EPOXY BONDING REINFORCING BARS AND ALL THREAD RODS IN CONCRETE

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Bonding reinforcing bars and all thread rods in concrete using epoxy adhesive.

B. Related sections:
   1. The Contract Documents are complementary; what is called for by one is as binding as if called for by all.
   2. It is the CONTRACTOR's responsibility for scheduling and coordinating the Work of subcontractors, suppliers, and other individuals or entities performing or furnishing any of CONTRACTOR's Work.
   3. The following sections are related to the Work described in this Section. This list of related sections is provided for convenience only and is not intended to excuse or otherwise diminish the duty of the CONTRACTOR to see that the completed Work complies accurately with the Contract Documents.
      a. Section 01410 - Regulatory Requirements.
      b. Section 03200 - Concrete Reinforcement.
      c. Section 05120 - Structural Steel.

1.02 REFERENCES

A. American National Standards Institute (ANSI):
   1. Standard B212.15 - Carbide Tipped Masonry Drills and Blanks for Carbide Tipped Masonry Drills.

B. ASTM International (ASTM):
   1. C 881 - Specification for Epoxy-Resin-Base Bonding Systems for Concrete.

C. ICC Evaluation Service, Inc.:
   1. Evaluation Report AC308 - Acceptance Criteria for Post Installed Adhesive Anchors in Concrete.

D. SSPC - Society for Protective Coatings - Steel Structures Painting Council:
   1. SP-10 Near-White Blast Cleaning.

1.03 SUBMITTALS

A. Product data: Furnish technical data for epoxy adhesives, including installation instructions, independent laboratory test results, and handling and storage instructions.

B. Quality control submittals:
   1. Epoxy manufacturer's past project experience data on at least 3 similar projects supplied with proposed products within the last 3 years.

2. Batch test reports for each batch of product delivered to site. Provide manufacturer's written certification that each batch delivered meets these Specifications, the intended uses on project, including capability to bond to damp concrete surfaces. Certification shall include batch test results for each product.
3. Epoxy manufacturer's written letter of certification identifying CONTRACTOR's employees qualified for operation of manufacturer's equipment, certified for installation of products, and trained through jobsite instruction conducted by manufacturer.
4. Copy of epoxy manufacturer's equipment service and repair manuals for each type of equipment delivered to project site.
5. Special Inspection: Provide detailed step-by-step instructions for the special inspection procedure in accordance with the IBC 2006 Code as specified in Section 01410.
6. ICC Evaluation Service, Inc., Evaluation Report meeting IBC 2006 and AC308-Acceptance Criteria for Post Installed Adhesive Anchors in Concrete.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Storage of epoxy components:
   1. Store epoxy components on pallets or shelving in a covered-storage area.
   2. Control temperature above 60 degrees Fahrenheit and dispose of product if shelf life has expired.
   3. If stored at temperatures below 60 degrees Fahrenheit, test components prior to use to determine if they still meet specified requirements.

PART 2 PRODUCTS

2.01 GENERAL

A. Like items of materials: Use end products of one manufacturer in order to achieve structural compatibility and singular responsibility.

2.02 EPOXY ADHESIVE FOR SELF-CONTAINED CARTRIDGE SYSTEM

A. Meet ASTM C 881, Type IV, Grade 3, Class B or C depending on site conditions.

B. Two-component, 100 percent solids, insensitive to moisture, and gray in color.

C. Cure temperature, pot life, and workability: Compatible for intended use and environmental conditions.

D. Container markings: Include manufacturer's name, product name, batch number, mix ratio by volume, product expiration date, ANSI hazard classification, and appropriate ANSI handling precautions.

E. Manufacturers: One of the following or equal:
   1. Hilti, Tulsa, OK, RE 500-SD High Strength Epoxy Doweling System.
   2. Simpson Strong-Tie Company, Inc., Pleasanton, CA, SET Epoxy-Tie Anchoring System.

2.03 ALL THREAD RODS

A. Materials: As specified in Section 05120.

2.04 REINFORCING BARS

A. Materials: As specified in Section 03200.

PART 3 EXECUTION

3.01 GENERAL

A. Provide epoxy adhesive packaged as follows:
   1. Disposable, self-contained cartridge system capable of dispensing both epoxy components in the proper mixing ratio, and fit into a manually or pneumatically operated caulking gun.
   2. Dispense components through a mixing nozzle that thoroughly mixes components.

3.02 HOLE SIZING AND INSTALLATION

A. Drilling holes:
   1. Do not damage or cut existing reinforcing bars, electrical conduits, or other items embedded in the existing concrete without acceptance by ENGINEER.
   2. The location of reinforcing bars or other obstructions shall be determined with a non-destructive indicator device.

B. Hole drilling equipment:
   1. Electric or pneumatic rotary impact type with medium or light impact.
   2. Drill Bits: Carbide-tipped in accordance with ANSI B212-15.
   3. Hollow drill bits with flushing air systems are preferred. Air supplied to hollow drill bits shall be free of oil, water, or other contaminants that will reduce bond.
   4. Where edge distances are less than 2 inches, use lighter impact equipment to prevent microcracking and concrete spalling during drilling process.

C. Hole diameter: Reinforcing bar diameter or all thread rod diameter plus 1/8 inch.

D. Obstructions in drill path:
   1. If an existing reinforcing bar or other obstruction is hit while drilling hole, stop drilling hole and fill the hole with drypack mortar. Relocate the hole to miss the obstruction and drill another hole. Repeat the above until the hole has been drilled to the required depth.
   2. Avoid drilling an excessive number of holes in an area of a structural member, which would excessively weaken the structural member and endanger the stability of the structure. Drypack holes which hit obstructions and allow drypack to reach strength equal to the existing concrete before drilling adjacent holes. Epoxy grout may be substituted for drypack when acceptable to ENGINEER.
   3. When existing reinforcing steel is encountered during drilling and when acceptable to ENGINEER, enlarge the hole by 1/8-inch, core through the existing reinforcing steel at the larger diameter, and resume drilling at original hole diameter.

4. Bent bar reinforcing bars: Where edge distances are critical, and striking reinforcing steel is likely, and if acceptable to ENGINEER, drill hole at 10 degree angle or less from axis of reinforcing bar or all thread rod being installed.

E. Install reinforcing bars and all thread rods to depth, spacings, and locations as indicated on the Drawings.

F. Cleaning holes:
   1. Insert long air nozzle into hole and blow out loose dust. Use air that is free of oil, water, or other contaminants that will reduce bond.
   2. Use a stiff bristle brush to vigorously brush hole to dislodge compacted drilling dust.
   3. Repeat step 1.
   4. Repeat above steps as required to remove drilling dust or other material that will reduce bond. The hole shall be clean and dry.

G. Cleaning reinforcing bars and all thread rods:
   1. Degrease and sandblast reinforcing bars and all thread rods over embedment length to near-white metal in accordance with Steel Structures Painting Council, SP-10 finish. The reinforcing bars and all thread rods shall be free of oil, grease, paint, dirt, mill scale, rust, or other coatings that will reduce bond.

H. Filling hole with epoxy:
   1. Fill hole with epoxy before inserting the reinforcing bar or all thread rod. Fill hole with epoxy starting from bottom of hole. Fill hole without creating air voids.
   2. Fill hole with sufficient epoxy so that excess epoxy is extruded out of the hole when the reinforcing bar or all thread rod is inserted into the hole.
   3. Do not install epoxy prior to receiving epoxy manufacturer's onsite training.

3.03 MANUFACTURERS' SERVICES

A. Furnish manufacturer's representative to conduct jobsite training for proper installation, handling, and storage of epoxy, for personnel who will perform actual installation. ENGINEER may attend training sessions.

3.04 FIELD QUALITY CONTROL

A. Testing laboratory hired by CONTRACTOR will:
   1. Review epoxy manufacturer's recommended special inspection procedures.
   2. Periodically inspect hole drilling operations for conformance with Contract Documents and manufacturer's recommendations.
   3. Certify in writing to the ENGINEER that depth and location of holes conform to the requirements in the Contract Documents prior to placement of epoxy.
   4. Continuously inspect placement of epoxy, and reinforcing bars installation.

B. CONTRACTOR shall replace failed or rejected reinforcing bars at the direction of the ENGINEER at no additional cost.

C. CONTRACTOR shall pay for increased quality control testing and reinforcing bar replacement caused by reinforcing bar failure.

D. Reinforcing bars which break off above the surface of the concrete or less than 2 inches below the surface of the concrete shall be cut off 2 inches below the surface of the concrete, and concrete shall be repaired.

E. The concrete shall be repaired where the bars pull out of the hole or break below the surface of the concrete and spall the concrete.

END OF SECTION

SECTION 03071

EPOXIES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Epoxy.
   2. Epoxy gel.
   3. Epoxy bonding agent.

B. Related sections:
   1. The Contract Documents are complementary; what is called for by one is as binding as if called for by all.
   2. It is the CONTRACTOR's responsibility for scheduling and coordinating the Work of subcontractors, suppliers, and other individuals or entities performing or furnishing any of CONTRACTOR's Work.
   3. The following Sections are related to the Work described in this Section. This list of Related Sections is provided for convenience only and is not intended to excuse or otherwise diminish the duty of the CONTRACTOR to see that the completed Work complies accurately with the Contract Documents.
      a. Section 03072 - Epoxy Resin/Portland Cement Bonding Agent.

1.02 REFERENCES

A. ASTM International (ASTM):
   1. D 638 - Standard Test Method for Tensile Properties of Plastics.
   2. D 695 - Standard Test Method for Compressive Properties of Rigid Plastics.
   3. D 790 - Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.

1.03 SYSTEM DESCRIPTION

A. Performance requirements:
   1. Provide epoxy materials that are new and use them within shelf life limitations set forth by manufacturer.
   2. Perform and conduct work of this Section in neat orderly manner.

1.04 SUBMITTALS

A. Product Data: Submit manufacturer's data completely describing epoxy materials.

B. Quality control submittals:
   1. Manufacturer's installation instructions.

PART 2 PRODUCTS

2.01 MATERIALS

A. Epoxy: Water-insensitive 2-part type low viscosity epoxy adhesive material containing 100 percent solids and meeting or exceeding following characteristics when tested in accordance with standards specified: Manufacturers: One of the following or equal:
   1. BASF, MBT, Concresive® Standard LVI.
   2. Sika Chemical Corp., Sikadur 35 Hi-Mod LV.

Physical Characteristic	Test Method	Required Results
Tensile Strength	ASTM D 638	8,000 pounds per square inch minimum at 14 days and 77 degrees Fahrenheit cure.
Flexure Strength	ASTM D 790	11,000 pounds per square inch minimum at 14 days and 77 degrees Fahrenheit cure.
Compressive Strength	ASTM D 695	16,000 pounds per square inch minimum at 24 hours and 77 degrees Fahrenheit cure.
Bond Strength	--	Concrete shall fail before failure of epoxy.
Gel Time for 5 Mil Film	--	4 hours maximum at 77 degrees Fahrenheit.
Elongation	ASTM D 638	1 percent minimum at 14 days and 77 degrees Fahrenheit.

B. Epoxy gel: Manufacturers: The following or equal:
   1. Sika Chemical Corp., Sikadur 31, Hi-Mod Gel.

C. Epoxy bonding agent: Manufacturers: One of the following or equal:
   1. BASF, MBT, Concresive® Liquid LPL.
   2. Sika Chemical Corp., Sikadur 32, Hi-Mod LPL.
   3. If increased tack time is required for concrete placement, epoxy resin/portland cement bonding agent as specified in Section 03072 may be used instead of epoxy bonding agent.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install and cure epoxy materials in accordance with manufacturer's installation instructions.

B. Epoxy:
   1. Apply in accordance with manufacturer's installation instructions.

C. Epoxy gel:
   1. Apply in accordance with manufacturer's installation instructions.
   2. Use for vertical or overhead work, or where high viscosity epoxy is required.
   3. Epoxy gel used for vertical or overhead work may be used for horizontal work.

D. Epoxy bonding agent:
   1. Apply in accordance with manufacturer's installation instructions.
   2. Bonding agent will not be required for filling form tie holes or for normal finishing and patching of similar sized small defects.

END OF SECTION

SECTION 03102

CONCRETE FORMWORK

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Concrete formwork.

B. Related sections:
   1. The Contract Documents are complementary; what is called for by one is as binding as if called for by all.
   2. It is the CONTRACTOR's responsibility for scheduling and coordinating the Work of subcontractors, suppliers, and other individuals or entities performing or furnishing any of CONTRACTOR's Work.
   3. The following sections are related to the Work described in this Section. This list of related sections is provided for convenience only and is not intended to excuse or otherwise diminish the duty of the CONTRACTOR to see that the completed Work complies accurately with the Contract Documents.
      a. Section 03300 - Cast-in-Place Concrete.
      b. Section 03600 - Grouts.
      c. Section 07900 - Joint Sealers.

1.02 REFERENCES

A. American Concrete Institute (ACI):
   1. 117 - Standard Specifications for Tolerances for Concrete Construction and Materials.

B. ASTM International (ASTM):
   1. A 82 - Standard Specification for Steel Wire, Plain, for Concrete Reinforcement.
   2. A 153 - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
   3. A 167 - Standard Specification for Stainless and Heat Resisting Chromium-Nickel Steel Plant, Sheet, and Strip.
   4. A 580 - Standard Specification for Stainless Steel Wire.

C. NSF International (NSF):
   1. 61 – Drinking Water System Components – Health Effects.

1.03 SYSTEM DESCRIPTION

A. Design requirements:
   1. Design of concrete forms, falsework, and shoring in accordance with local, state, and federal regulations.
   2. Design forms and ties to withstand concrete pressures without bulging, spreading, or lifting of forms.

B. Performance requirements:
   1. Construct forms so that finished concrete conforms to shapes, lines, grades, and dimensions indicated on the Drawings.
   2. It is intended that surface of concrete after stripping presents smooth, hard, and dense finish that requires minimum amount of finishing.
   3. Provide sufficient number of forms so that the work may be performed rapidly and present uniform appearance in form patterns and finish.

C. National Sanitary Foundation (NSF):
   1. 61 - Drinking Water System Components: Health.
   2. Use forms that are clean and free from dirt, concrete, and other debris. Coat with acceptable form release oil if required, prior to use or reuse. For water treatment plants and water reservoirs, use form release oil in accordance with NSF 61.

1.04 SUBMITTALS

A. Information on the CONTRACTOR's proposed forming system: Submit in such detail as the ENGINEER may require to assure himself that intent of the Specifications can be complied with by use of proposed system.

B. Alternate combinations of plywood thickness and stud spacing: May be submitted.

1.05 QUALITY ASSURANCE

A. Qualifications of formwork manufacturers: Use only forming systems manufactured by manufacturers having minimum 5 years experience, except as otherwise specified, or accepted in writing by the ENGINEER.

B. Regulatory requirements: Install work of this Section in accordance with local, state, and federal regulations.

1.06 PROJECT CONDITIONS

A. Requirements due to weather condition:
   1. Removal of formwork: Do not remove forms from concrete which has been placed when outside ambient air temperature is below 50 degrees Fahrenheit until concrete has attained specified strength as determined by test cylinders stored in field under equivalent conditions as concrete structure.

PART 2 PRODUCTS

2.01 MANUFACTURED UNITS

A. Form ties:
   1. General:
      a. Provide form ties for forming system selected that are manufactured by recognized manufacturer of concrete forming equipment.
      b. Do not use wire ties or wood spreaders of any form.
      c. Provide ties of type that accurately tie, lock, and spread forms.

d. Provide form ties of such design that when forms are removed, they locate no metal or other material within 1-1/2 inches of the surface of the concrete.
e. Do not allow holes in forms for ties to allow leakage during placement of concrete.

2. Cone-snap or flat bar form ties:
   a. Cone-snap ties shall form a cone shaped depression in the concrete with a minimum diameter of 1 inch at the surface of the concrete and 1-1/2 inches deep.
   b. Provide neoprene waterseal washer that is located near the center of the concrete.
3. Taper ties:
   a. Neoprene plugs for taper tie holes: Size so that after they are driven, plugs are located in center third of wall thickeners.
   b. Dry-pack mortar for filling taper tie holes:
      1) Consist of mix of 1 part of portland cement to 1 part of plaster sand.
      2) Amount of water to be added to cement-sand mix is to be such that mortar can be driven into holes and be properly compacted.
      3) Admixtures or Additives: Are not to be used in dry-pack mortar.

B. Built-up plywood forms:
1. Built-up plywood forms may be substituted for prefabricated forming system subject to following minimum requirements:
   a. Size and material:
      1) Full size 4-by 8-foot plywood sheets, except where smaller pieces are able to cover entire area.
      2) Sheet construction: 5-ply plywood sheets, 3/4-inch nominal, made with 100 percent waterproof adhesive, and having finish surface that is coated or overlaid with surface which is impervious to water and alkaline calcium and sodium hydroxide of cement.
   b. Wales: Minimum 2- by 4-inch lumber.
   c. Studding and wales: Contain no loose knots and be free of warps, cups, and bows.

C. Steel or steel framed forms:
1. Steel forms: Provide forms that are:
   a. Rigidly constructed and capable of being braced for minimum deflection of finish surface.
   b. Capable of providing finish surfaces that are flat without bows, cups, or dents.
2. Steel framed plywood forms:
   a. Provide forms that are rigidly constructed and capable of being braced.
   b. Plywood paneling: 5-ply, 5/8-inch nominal or 3/4-inch nominal, made with 100 percent waterproof adhesive, and having finish surface that is coated or overlaid with surface which is impervious to water and alkaline calcium and sodium hydroxide of cement.

D. Incidentals:
1. External angles:
   a. Where not otherwise indicated on the Drawings, provide with 3/4-inch bevel, formed by utilizing true dimensioned wood or solid plastic chamfer strip on walkways, slabs, walls, beams, columns, and openings.

b. Provide 1/4-inch bevel formed by utilizing true dimensioned wood or solid plastic chamfer strip on walkways, walls, and slabs at expansion, contraction, and construction joints.

2. Keyways: Steel, plastic, or lumber treated with form coating, applied according to label directions.

PART 3 EXECUTION

3.01 EXAMINATION

A. Site verification of conditions:
   1. Do not place any concrete until all forms have been thoroughly checked for alignment, level, strength, and to assure accurate location of all mechanical and electrical inserts or other embedded items.

3.02 INSTALLATION

A. Forms and accessories:
   1. Vertical forms:
      a. Remain in place minimum of 24 hours after concrete is placed.
      b. If, after 24 hours, concrete has sufficient strength and hardness to resist surface or other damage, forms may be removed.
   2. Other forms supporting concrete and shoring: Remain in place as follows:
      a. Sides of footings: 24 hours minimum.
      b. Vertical sides of beams, girders, and similar members: 48 hours minimum.
      c. Slabs, beams, and girders: Until concrete strength reaches specified strength f'_c or until shoring is installed.
      d. Shoring for slabs, beams, and girders: Shore until concrete strength reaches specified strength.
      e. Wall bracing: Brace walls until concrete strength of beams and slabs laterally supporting wall reaches specified strength.
   3. Green concrete:
      a. No heavy loading on green concrete will be permitted.
      b. Green concrete is defined as concrete with less than 100 percent of specified strength f'_c.
   4. Immediately after forms are removed, carefully examine concrete surfaces, and repair any irregularities in surfaces and finishes as specified in Section 03300.

B. Form ties:
   1. Cone-snap rod and bar ties: Tie forms together at not more than 2-foot centers vertically and horizontally. After forms are removed from wall, fill tie holes as follows:
      a. Remove form ties from surfaces.
      b. Roughen cone shaped tie holes by heavy sandblasting before repair.
      c. Dry pack cone shaped tie holes with dry-pack mortar as specified in Section 03600.
   2. Taper ties:
      a. After forms and taper ties are removed from wall, plug tie holes with neoprene plug as follows:
         1) Heavy sandblast and then clean tie holes.

2) After cleaning, drive neoprene plug into each of taper tie holes with steel rod. Final location of neoprene plug shall be in center third of wall thickness. Bond neoprene plug to concrete with epoxy.
3) Locate steel rod in cylindrical recess, made in plug, during driving:
a) At no time are plugs to be driven on flat area outside cylindrical recess.

b. Dry-pack of taper tie holes: After installing plugs in tie holes:
1) Coat tie hole surface with epoxy bonding agent and fill with dry-pack mortar as specified in Section 03600:
a) Dry-pack mortar: Place in holes in layers with thickness not exceeding tie hole diameter and heavily compact each layer.
b) Dry-pack the outside of the hole no sooner than 7 days after the inside of the hole has been dry packed.
c) Wall surfaces in area of dry-packed tie holes: On the water side of water containing structures and the outside of below grade walls:
(1) Cover with minimum of 10 mils of epoxy gel.
(2) Provide epoxy gel coating on wall surfaces that extend minimum of 2 inches past dry-pack mortar filled tie holes.
(3) Provide finish surfaces that are free from sand streaks or other voids.

C. Built-up plywood forms:
1. Studding:
a. Spaced at 16 inches or 24 inches on center.
b. Closer spacing may be required depending upon strength requirements of the forms, in order to prevent any bulging surfaces on faces of finished concrete work.
c. Install studs perpendicular to grain of exterior plys of plywood sheets.
2. Wales: Form wales of double lumber material with minimum size as specified in this Section.
3. Number of form reuses: Depends upon durability of surface coating or overlay used, and ability to maintain forms in condition such that they are capable of producing flat, smooth, hard, dense finish on concrete when stripped.

D. Steel or steel framed forms:
1. Steel forms:
a. Adequately brace forms for minimum deflection of finish surface.
2. Steel framed plywood forms:
a. Rigidly construct and brace with joints fitting closely and smoothly.
b. Number of form reuses: Depends upon durability of surface coating or overlay used.
3. Built-up plywood forms: As specified in this Section may be used in conjunction with steel forms or steel framed plywood forms for special forming conditions such as corbels and forming around items which will project through forms.

E. Bracing and alignment of forms:
1. Line and grade: Limit deviations to tolerances which will permit proper installation of structural embedded items or mechanical and electrical equipment and piping.

2. Formwork:
    a. Securely brace, support, tie down, or otherwise hold in place to prevent any movement.
    b. Make adequate provisions for uplift pressure, lateral pressure on forms, and deflection of forms.
3. When second lift is placed on hardened concrete: Take special precautions in form work at top of old lift and bottom of new lift to prevent:
    a. Spreading and vertical or horizontal displacement of forms.
    b. Grout "bleeding" on finish concrete surfaces.
4. Pipe stubs, anchor bolts, and other embedded items: Set in forms where required.
5. Cracks, openings, or offsets at joints in formwork: Close those that are 1/16-inch or larger by tightening forms or by filling with acceptable crack filler.

F. Incidentals:
1. Keyways: Construct keyways as indicated on the Drawings.
2. Reentrant angles: May be left square.
3. Level strips: Install level strips at top of wall concrete placements to maintain true line at horizontal construction joints.
4. Inserts:
    a. Encase pipes, anchor bolts, steps, reglets, castings, and other inserts, as indicated on the Drawings or as required, in concrete.
    b. Use dovetail anchors in conjunction with slots as specified in this section and as may be necessary for required work.

G. Pipe and conduit:
1. Install pipe and conduit in structures as indicated on the Drawings, and seal with materials as specified in Section 07900.

3.03 CONSTRUCTION

A. Tolerances:
1. Finish concrete shall conform to shapes, lines, grades, and dimensions indicated on the Drawings.
2. The maximum deviation from true line and grade shall not exceed tolerances listed below at time of acceptance of project.
3. General: In accordance with ACI 117, paragraphs 2.1 through 2.2 and paragraphs 4.0 through 4.6, except as modified in following:
    a. Slabs:
        1) Slope: Uniformly sloped to drain when slope is indicated on the Drawings.
        2) Slabs Indicated to Be Level: Have maximum deviation of 1/8-inch in 10 feet without any apparent changes in grade.
    b. On circular tank walls: The CONTRACTOR may deviate from finish line indicated on the Drawings by use of forms with chord lengths not to exceed 2 feet.
    c. Inserts: Set inserts to tolerances required for proper installation and operation of equipment or systems to which insert pertains.

d. Maximum tolerances: As follows:

Item	Tolerance
Sleeves and Inserts	Plus 1/8 Minus 1/8 inches
Projected Ends of Anchor Bolts	Plus 1/4 Minus 0.0 inches
Anchor Bolt Setting	Plus 1/16 Minus 1/16 inches

END OF SECTION

SECTION 03150

CONCRETE ACCESSORIES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Polyvinyl chloride waterstop.
   2. Preformed synthetic sponge rubber expansion joint material.
   3. Preformed bituminous fiber expansion joint material.

1.02 REFERENCES

A. ASTM International (ASTM):
   1. A 240 - Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
   2. D 570 - Standard Test Method for Water Absorption of Plastics.
   3. D 624 - Standard Test Method for Tear Strength of Conventional Vulcanized Rubber and Thermoplastic Elastomers.
   4. D 638 - Standard Test Method for Tensile Properties of Plastics.
   5. D 746 - Standard Test Method for Brittleness Temperature of Plastics and Elastomers by Impact.
   6. D 747 - Standard Test Method for Apparent Bending Modulus of Plastics by Means of a Cantilever Beam.
   7. D 792 - Standard Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement.
   8. D 2240 - Standard Test Method for Rubber Property – Durometer Hardness.

B. U. S. Army Corps of Engineers (USACE):
   1. CRD-C-572, Specification for Polyvinyl Chloride Waterstop.

1.03 SUBMITTALS

A. Product data:
   1. Polyvinyl chloride waterstops: Complete physical characteristics.
   2. Preformed expansion joint material: Sufficient information on each type of material for review to determine conformance of material to requirements specified.

B. Samples:
   1. Polyvinyl chloride waterstop.

C. Laboratory test reports: Indicating that average properties of polyvinyl chloride waterstops material and finish conform to requirements specified in this Section.

D. Quality control submittals:
   1. Certificates of compliance:
      a. Written certificates that polyvinyl chloride waterstops supplied on this Project meet or exceed physical property requirements of current USACE CRD-C-572 and the requirements of this Section.
   2. Manufacturer's instructions: For materials specified in this Section that are specified to be installed with such instructions.

1.04 QUALITY ASSURANCE

A. Mock-ups:
   1. Welding demonstration:
      a. Demonstrate ability to weld acceptable joints in polyvinyl chloride waterstops before installing waterstop in forms.

B. Field joints:
   1. Polyvinyl chloride waterstops field joints: Shall be free of misalignment, bubbles, inadequate bond, porosity, cracks, offsets and other defects which would reduce the potential resistance of the material to water pressure at any point. Replace defective joints. Remove faulty material from the site and disposed of by the CONTRACTOR at its own expense.

C. Inspections:
   1. Quality of welded joints will be subject to acceptance of the ENGINEER.
   2. Polyvinyl chloride waterstop: The following defects that represent a partial list that will be grounds for rejection:
      a. Offsets at joints greater than 1/16-inch or 15 percent of the material thickness, at any point, whichever is less.
      b. Exterior crack at joint, due to incomplete bond, which is deeper than 1/16-inch or 15 percent of the material thickness, at any point, whichever is less.
      c. Any combination of offset or crack which will result in a net reduction in the cross section of the waterstop in excess of 1/16-inch or 15 percent of the material thickness, at any point, whichever is less.
      d. Misalignment of the joint, which will result in misalignment of the waterstop in excess of 1/2-inch in 10 feet.
      e. Porosity in the welded joint as evidenced by visual inspection.
      f. Bubbles or inadequate bonding.

PART 2 PRODUCTS

2.01 MATERIALS

A. Polyvinyl chloride waterstops: Manufactured from prime virgin polyvinyl chloride plastic compound containing the plasticizers, resins, stabilizers, and other materials necessary to meet the requirements of this Specification. No scrap or reclaimed material shall be used.

2.02 MANUFACTURED UNITS

A. Waterstops:
   1. Polyvinyl chloride waterstops:
      a. Manufacturers: One of the following or equal:
         1) Vinylex Corporation, Kwik-Tie.
         2) Greenstreak Plastic Products Company, Inc.
      b. Type: Ribbed waterstop:
         1) Construction joints: 6-inch wide ribbed type.
            a) Greenstreak Profile No. 679 (or equal).
         2) Expansion joint for wall penetrations for concrete encased electrical duct banks: 6-inch ribbed type with hollow center bulb.
            a) Greenstreak Profile No. 717 (or equal).
         3) Expansion joints: 9-inch wide ribbed type with hollow center bulb.
            a) Greenstreak Profile No. 735 (or equal).
      c. Provide polyvinyl chloride waterstops complying with following requirements:

Physical Characteristics	Test Method	Required Results
Specific Gravity	ASTM D 792	Not less than 1.3.
Hardness	ASTM D 2240	70 to 90 Type A Shore durometer.
Tensile Strength	ASTM D 638	Not less than 2,000 pounds per square inch.
Ultimate Elongation	ASTM D 638	Not less than 350 percent
Alkali Extraction	CRD-C-572	7 day weight change between minus 0.1 percent and plus 0.25 percent.
Low Temperature Brittle Point	ASTM D 746	Not more than minus 35 degrees Fahrenheit.
Water Absorption	ASTM D 570	Not more than 0.15 percent after 24 hours.
Accelerated Extraction Tensile	CRD-C-572	Not less than 2,000 pounds per square inch.
Stiffness in Flexure	ASTM D 747	Not less than 725 pounds per square inch.
Tear Resistance	ASTM D 624	Not less than 300 pounds per inch.
Weight Requirements		
6 inch Waterstops	–	Weigh not less than 130 pounds per 100 linear feet.
9 inch Waterstops	–	Weigh not less than 220 pounds per 100 linear feet.
Thickness	–	3/8-inch
Center Bulb		
6 inch Waterstops	–	7/8-inch or 1-inch nominal outside diameter.
9 inch Waterstops	–	1-inch nominal outside diameter. For expansion joints 1 inch and narrower and 2 inches for expansion joints wider than 1-inch.

Physical Characteristics	Test Method	Required Results
Allowable Tolerances		
Width	–	Plus or minus 3/16-inch.
Thickness	–	Plus or minus 1/32-inch.

d. Dumbbell type waterstop will not be allowed unless otherwise specified or indicated on the Drawings.

B. Preformed expansion joint materials:
1. Preformed synthetic sponge rubber expansion joint material:
a. Manufacturers: One of the following or equal:
1) Tamms Industries, Inc., Cementone.
2) Burke Concrete Accessories Inc., Neoprene Sponge Rubber Expansion Joint.
2. Preformed bituminous fiber expansion joint material:
a. Manufacturers: One of the following or equal:
1) Tamms Industries, Inc., Hornboard/fiber.
2) Burke Concrete Accessories Inc., Fiber Expansion Joint.
3. Use specific type in applications as indicated on the Drawings.
4. No scrap or recycled material shall be used.

PART 3 EXECUTION

3.01 INSTALLATION

A. Waterstops - general:
1. Waterstops shall be stored so as to permit free circulation of air around the waterstop material and to prevent direct exposure to sunlight.
2. Install waterstops in concrete joints where indicated on the Drawings.
3. Carry waterstops in walls into lower slabs and join to waterstops in slabs with appropriate types of fittings.
4. In waterbearing structures: Provide all joints with waterstops, whether indicated on the Drawings or not.
5. Provide waterstops that are continuous.
6. Set waterstops accurately to position and line as indicated on the Drawings.
7. Hold and securely fix edges in position at intervals of not more than 24 inches so that they do not move during placing of concrete.
8. Position the waterstop so that symmetrical halves of the waterstop are equally divided between the concrete pours. The center axis of the waterstop shall be coincident with the centerline of the joint.
9. Do not drive nails, screws, or other fasteners through waterstops in vicinity of construction joints.
10. Use wires at not more than 24 inches on centers near outer edge of the waterstop to tie waterstops into position.
11. Special clips may be used in lieu of wires, at CONTRACTOR's option.
12. Terminate waterstops 3 inches from top of finish surfaces of walls and slabs unless otherwise specified or indicated on the Drawings.

13. When any waterstop is installed in the concrete on one side of a joint, while the other half or portion of the waterstop remains exposed to the atmosphere for more than 2 days, suitable precautions shall be taken to shade and protect the exposed waterstop from direct rays of sunlight during the entire exposure and until the exposed portion is embedded in concrete.
14. When placing concrete at waterstops in slabs, lift the edge of the waterstop while placing concrete below the waterstop. Manually force the waterstop against and into the concrete. Then cover the waterstop with fresh concrete.

B. Polyvinyl chloride waterstops:
   1. Install waterstops so that joints are watertight.
   2. Weld joints such as unions, crosses, ells, and tees, with thermostatically controlled equipment recommended by waterstop manufacturer:
      a. The material shall not be damaged by heat sealing.
      b. Make joints by overlapping then simultaneously cut the ends of the sections to be spliced so they will form a smooth even joint. Heat the cut ends with the splicing tool until the plastic melts. Press the 2 ends together until the plastic cools.
      c. The continuity of the waterstop ribs and tubular center axis shall be maintained.
      d. The splices shall have a tensile strength of not less than 60 percent of the unspliced materials tensile strength.
   3. Butt joints of the ends of 2 identical waterstop sections may be made while the material is in the forms.
   4. All joints with waterstops involving more than 2 ends to be joined together, and all joints that involve an angle cut, alignment change, or the joining of 2 dissimilar waterstop sections shall be prefabricated by the CONTRACTOR or the manufacturer prior to placement in the forms, providing not less than 24 inch long strips of waterstop material beyond the joint. Upon being inspected and accepted, install such prefabricated waterstop joint assemblies in the forms and the ends of the 24-inch strips shall be butt welded to the straight run portions of waterstop in place in the forms.
   5. Vertical crosses and tees shall be factory prefabricated by the manufacturer. Horizontal crosses or tees may be field or factory welded.
   6. Split type waterstop will not be permitted except where specifically indicated on the Drawings.

C. Joints:
   1. Construct construction and expansion joints as indicated on the Drawings.
   2. Preformed expansion joint material: Fasten expansion joint strips to concrete, masonry, or forms with adhesive. No nailing will be permitted, nor shall expansion joint strips be placed without fastening.

END OF SECTION

SECTION 03200

CONCRETE REINFORCEMENT

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Concrete reinforcement.

B. Related sections:
   1. Section 01410 - Regulatory Requirements.

1.02 REFERENCES

A. American Concrete Institute (ACI):
   1. 315 - Detailing Manual: Details and Detailing of Concrete Reinforcement.
   2. 318 - Building Code Requirements for Structural Concrete.
   3. 350 - Code Requirements for Environmental Engineering Concrete Structures.

B. ASTM International (ASTM):
   1. A 143 - Standard Practice for Safeguarding Against Embrittlement of Hot-Dip Galvanized Structural Steel Products and Procedure for Detecting Embrittlement.
   2. A 185 - Standard Specification for Steel Welded Wire Reinforcement, Plain, for Concrete.
   3. A 615 - Standard Specification for Deformed and Plain Carbon Steel Bars for Concrete Reinforcement.
   4. A 706 - Standard Specification for Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement.
   5. A 767 - Standard Specification for Zinc-Coated (Galvanized) Steel Bars for Concrete Reinforcement.

C. American Welding Society (AWS):
   1. D1.4 - Structural Welding Code - Reinforcing Steel.

1.03 DEFINITIONS

A. Give away bars: Bars that are not required by Contract Documents, that are installed by the CONTRACTOR to support the reinforcing bar.

1.04 SYSTEM DESCRIPTION

A. The Drawings contain general notes concerning amount of reinforcement and placing, details of reinforcement at wall corners and intersections, and details of extra reinforcement around openings in concrete.

1.05 SUBMITTALS

A. Shop drawings:
   1. Changes to reinforcing steel Contract Drawing requirements:
      a. Indicate in separate letter submitted with shop drawings any changes of requirements indicated on the Drawings for reinforcing steel.
      b. Such changes will not be acceptable unless the ENGINEER has accepted such changes in writing.
   2. Reinforcement Detail Drawings:
      a. Review of reinforcement shop drawings by the ENGINEER will be limited to general compliance with the Contract Documents.
      b. Reinforcement shop drawings shall be submitted as a complete package for a specific structure. Partial submittals will be rejected.
      c. Submittals shall be on size 30-inch x 42-inch drawings.

B. Samples:
   1. Bar supports: Submit samples of chairs proposed for use along with letter stating where each type of chair will be used.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Packing and shipping:
   1. Deliver bars bundled and tagged with identifying tags.

B. Acceptance at Site:
   1. Reinforcing bars: Deliver reinforcing bars lacking grade identification marks accompanied by manufacturer's guarantee of grade.

1.07 SEQUENCING AND SCHEDULING

A. Bar supports: Do not place concrete until samples and attached data of bar supports has been accepted by the ENGINEER.

PART 2 PRODUCTS

2.01 MATERIALS

A. Reinforcement:
   1. General: Provide reinforcing steel that is of quality specified, free from excessive rust or scale or any defects affecting its usefulness.

B. Reinforcing bars:
   1. Reinforcing bars to be embedded in concrete or masonry: Grade 60 deformed bars in accordance with ASTM A 615 except as specified in the next two subparagraphs.

C. Tie wires: Annealed steel.

D. Welded wire fabric reinforcement:
   1. In accordance with ASTM A 185.
   2. Fabric may be used in place of reinforcing bars if accepted by the ENGINEER.
   3. Provide welded wire fabric in flat sheet form.

4. Provide welded wire fabric having cross-sectional area per linear foot of not less than cross-sectional area per linear foot of reinforcing bars indicated on the Drawings.

2.02 FABRICATION

A. Shop assembly:
   1. Cut and bend bars in accordance with provisions of ACI 315, ACI 318, and ACI 350.
   2. Bend bars cold.
   3. Provide bars free from defects and kinks and from bends not indicated on the Drawings.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verification of conditions:
   1. Reinforcing bars:
      a. Verify that bars are new stock free from rust scale, loose mill scale, excessive rust, dirt, oil, and other coatings which adversely affect bonding capacity when placed in the work.

3.02 PREPARATION

A. Surface preparation:
   1. Reinforcing bars: Thin coating of red rust resulting from short exposure will not be considered objectionable. Thoroughly clean any bars having rust scale, loose mill scale, or thick rust coat.
   2. Cleaning of reinforcement materials: Remove concrete or other deleterious coatings from dowels and other projecting bars by wire brushing or sandblasting before bars are embedded in subsequent concrete placement.

3.03 INSTALLATION

A. Reinforcing bars:
   1. No field bending of bars will be allowed.

B. Placing reinforcing bars:
   1. Accurately place bars and adequately secure them in position.
   2. Overlap bars at splices as indicated on the Drawings or specified.
   3. Unless specifically otherwise indicated on the Drawings, install bars at lap splices in contact with each other and fasten bars together with tie wire.
   4. If lap splice length for bars in concrete is not specified or indicated on the Drawings, bars shall be lap spliced in accordance with ACI 318 and ACI 350.
   5. If not indicated on the Drawings and not specified in Division 4, lap splice bars in masonry in accordance with the building code as specified in Section 01410.
   6. Bar supports:
      a. Provide in sufficient number to prevent sagging and to support loads during construction, but in no case less than quantities and at locations as indicated in ACI 315.

b. Support reinforcing for concrete placed on ground by standard manufactured chairs, with steel plates for resting on ground.
c. Do not use brick, broken concrete masonry units, spalls, rocks, or similar material for supporting reinforcing steel.
d. Do not use give away bars that have less cover than required by the Contract Documents. Do not adjust location of reinforcement required by the Contract Documents to provide cover to the give away bars.

7. If not indicated on the Drawings, provide protective concrete cover in accordance with ACI 318 and ACI 350.

C. Tying of bar reinforcement:
1. Fasten bars securely in place with wire ties.
2. Tie bars sufficiently often to prevent shifting.
3. There shall be at least 3 ties in each bar length (does not apply to dowel lap splices or to bars shorter than 4 feet, unless necessary for rigidity).
4. Tie slab bars at every intersection around periphery of slab.
5. Tie wall bars and slab bar intersections other than around periphery at not less than every fourth intersection, but at not greater than following maximum spacings:

Bar Size	Slab Bars Spacing Inches	Wall Bars Spacing Inches
Bars Number 5 and Smaller	60	48
Bars Number 6 through Number 9	96	60
Bars Number 10 and Number 11	120	96

6. After tying wire ties, bend ends of wire ties in towards the center of the concrete section. Wire ties shall conform to the cover requirements of the reinforcing bars.
7. Above tying requirements do not apply to reinforcement for masonry.

D. Lap splices of reinforcing bars:
1. Where bars are to be lapped spliced at joints in concrete, ensure bars project from concrete first placed, minimum length equal to lap splice length indicated on the Drawings.
2. Where lap splice length is not indicated on the Drawings, then provide lap splice length in accordance with ACI 318, ACI 350, and as specified in this Division.

E. Welded wire fabric reinforcement:
1. Install necessary wiring, spacing chairs, or supports to keep welded wire fabric in place while concrete is being placed.
2. Bend fabric as indicated on the Drawings or required to fit work.
3. Unroll or otherwise straighten fabric to make perfectly flat sheet before placing in the Work.
4. Lap splice welded wire fabric as indicated on the Drawings.
5. If lap splice length is not indicated on the Drawings, splice fabric in accordance with ACI 318 and ACI 350.

END OF SECTION

SECTION 03300

CAST-IN-PLACE CONCRETE

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Cast-in-place concrete.

B. Related sections:
   1. The Contract Documents are complementary; what is called for by one is as binding as if called for by all.
   2. It is the CONTRACTOR's responsibility for scheduling and coordinating the Work of subcontractors, suppliers, and other individuals or entities performing or furnishing any of CONTRACTOR's Work.
   3. The following sections are related to the Work described in this Section. This list of related sections is provided for convenience only and is not intended to excuse or otherwise diminish the duty of the CONTRACTOR to see that the completed Work complies accurately with the Contract Documents.
      a. Section 03071 - Epoxies.
      b. Section 03150 - Concrete Accessories.
      c. Section 03366 - Tooled Concrete Finishes.
      d. Section 07900 - Joint Sealers.

1.02 REFERENCES

A. American Concrete Institute (ACI):
   1. 305 - Standard Specification for Hot Weather Concreting.
   2. 318 - Building Code Requirements for Structural Concrete and Commentary.
   3. 350 - Code Requirements for Environmental Engineering Concrete Structures and Commentary.
   4. Manual of Concrete Practice.
   5. Recommended Practices.

B. ASTM International (ASTM):
   1. C 31 - Standard Practice for Making and Curing Concrete Test Specimens in the Field.
   2. C 33 - Standard Specification for Concrete Aggregates.
   3. C 39 - Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.
   4. C 40 - Standard Test Method for Organic Impurities in Fine Aggregates for Concrete.
   5. C 42 - Standard Test Method of Obtaining and Testing Drilled Cores and Sawed Beams of Concrete.
   6. C 88 - Standard Test Method of Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate.
   7. C 94 - Standard Specification for Ready-Mixed Concrete.
   8. C 114 - Standard Test Methods for Chemical Analysis of Hydraulic Cement.

9. C 117 - Standard Test Method for Materials Finer that 75-m (No. 200) Sieve in Mineral Aggregates by Washing.
10. C 123 - Standard Test Method for Lightweight Particles in Aggregate.
11. C 131 - Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.
12. C 136 - Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
13. C 142 - Standard Test Method for Clay Lumps and Friable Particles in Aggregate.
14. C 143 - Standard Test Method for Slump of Hydraulic-Cement Concrete.
15. C 150 - Standard Specification for Portland Cement.
16. C 156 - Standard Test Method for Water Retention by Concrete Curing Materials.
17. C 171 - Standard Specifications for Sheet Materials for Curing Concrete.
18. C 172 - Standard Practice for Sampling Freshly Mixed Concrete.
19. C 173 - Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method.
20. C 227 - Standard Test Method for Potential Alkali Reactivity of Cement-Aggregate Combinations (Mortar-Bar Method).
21. C 260 - Standard Specification for Air-Entraining Admixtures for Concrete.
22. C 289 - Standard Test Method for Potential Alkali-Silica Reactivity of Aggregates (Chemical Method).
23. C 295 - Standard Guide to Petrographic Examination of Aggregates for Concrete.
24. C 309 - Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete.
25. C 311 - Standard Test Methods for Sampling and Testing Fly Ash or Natural Pozzolans for Use as a Mineral Admixture in Portland-Cement Concrete.
26. C 469 - Standard Test Method for Static Modulus of Elasticity and Poisson's Ratio of Concrete in Compression.
27. C 494 - Standard Specification for Chemical Admixtures for Concrete.
28. C 595 - Standard Specification for Blended Hydraulic Cements.
29. C 618 - Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete.
30. ASTM 1315 - Standard Specification for Liquid Membrane-Forming Compounds Having Special Properties for Curing and Sealing Concrete.
31. D 75 - Standard Practice for Sampling Aggregates.
32. D 2103 - Standard Specification for Polyethylene Film and Sheeting.

1.03 DEFINITIONS

A. Alkali: Is defined as the sum of sodium oxide and potassium oxide calculated as sodium oxide.

B. Cementitious materials: Defined as portland cement and pozzolan admixture.

C. Hairline crack: Crack with a crack width of less than 4 thousandths of an inch.

1.04 SYSTEM DESCRIPTION

A. Performance requirements:
   1. General:
      a. Except as otherwise specified, provide concrete composed of portland cement, fly ash, fine aggregate, coarse aggregate, admixtures, and water so proportioned and mixed as to produce plastic, workable mixture in accordance with requirements as specified in this Section and suitable to specific conditions of placement.
      b. Proportion materials in a manner such that will secure lowest water-cement ratio which is consistent with good workability, plastic, cohesive mixture, and one which is within specified slump range.
      c. Proportion fine and coarse aggregates in manner such as not to produce harshness in placing or honeycombing in structures.
   2. It is the intent of this Section to secure for every part of the Work concrete and grout of homogeneous structure, which when hardened will have required strength, watertightness, and durability:
      a. It is recognized that some surface hairline cracks and crazing will develop in the concrete surfaces. Hairline and crazing cracks 10 mils or less are acceptable.
      b. Construction and expansion joints have been specified and positioned in structures as indicated on the Drawings, and curing methods specified, for purpose of reducing number and size of cracks, due to normal expansion and contraction expected from specified concrete mixes.
      c. Class A and Class B concrete: Watertight: Repair cracks which develop in walls or slabs and repair cracks which show any signs of leakage until all leakage is stopped.
      d. Pressure inject visible cracks, other than hairline cracks and crazing, in following areas with epoxy as specified in Section 03931:
         1) Floors and walls of water bearing structures.
         2) Walls and overhead slabs of passageways or occupied spaces, outsides of which are exposed to weather or may be washed down and are not specified to receive separate waterproof membrane.
         3) Other Items Not Specified to Receive Separate Waterproof Membrane: Slabs over water channels, wet wells, reservoirs, and other similar surfaces.
      e. Walls or slabs, as specified above, that leak or sweat because of porosity or cracks too small for successful pressure grouting: Seal on water or weather side by coatings of surface sealant system, as specified in this Section.
      f. Grouting and Sealing: Continue as specified above until structure is watertight and remains watertight for not less than one year after final acceptance or date of final repair, whichever occurs later in time.
   3. Workmanship and methods: Provide concrete work, including detailing of reinforcing, conforming with best standard practices and as set forth in ACI 318, ACI 350, Manuals, and Recommended Practices.

1.05 SUBMITTALS

A. Product data: Submit data completely describing products.

B. Information on Heating equipment to be used for cold weather concreting: Submit information on type of equipment to be used for heating materials and/or new concrete in process of curing during excessively cold weather.

C. For conditions that promote rapid drying of freshly placed concrete such as low humidity, high temperature, and wind: Submit corrective measures proposed for use prior to placing concrete.

D. Copies of tests of concrete aggregates: Submit certified copies in triplicate of commercial laboratory tests not more than 90 days old of all samples of concrete aggregates:
   1. Fine aggregate:
      a. Clay lumps.
      b. Reactivity.
      c. Shale and chert.
      d. Soundness.
      e. Color.
      f. Decantation.
   2. Coarse aggregate:
      a. Clay lumps and friable particles.
      b. Reactivity.
      c. Shale and chert.
      d. Soundness.
      e. Abrasion loss.
      f. Coal and lignite.
      g. Materials finer than 200 sieve.

E. Sieve analysis: Submit sieve analyses of fine and coarse aggregates being used in triplicate at least every 3 weeks and at any time there is significant change in grading of materials.

F. Concrete mixes: Submit full details, including mix design calculations for concrete mixes proposed for use for each class of concrete:
   1. Include information on correction of batching for varying moisture contents of fine aggregate.
   2. Submit source quality test records with mix design submittal.
      a. Include calculations for f'_{cr} based on source quality test records.

G. Trial batch test data:
   1. Submit data for each test cylinder.
   2. Submit data that identifies mix and slump for each test cylinder.

H. Sequence of concrete placing: Submit proposed sequence of placing concrete showing proposed beginning and ending of individual placements.

I. Curing compound: Submit complete data on proposed compound.

J. If either fine or coarse aggregate is batched from more than one bin: Submit analyses for each bin, and composite analysis made up from these, using proportions of materials to be used in mix.

K. Cement mill tests: Include alkali content, representative of each shipment of cement for verification of compliance with specified requirements.

L. Pozzolan certificate of compliance: Identify source of pozzolan and certify compliance with requirements of ASTM C 618.

M. Information on mixing equipment.

N. Repair of defective concrete: Proposed methods, products, design mix.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Packing and shipping:
   1. Deliver, store, and handle concrete materials in manner that prevents damage and inclusion of foreign substances.
   2. Deliver and store packaged materials in original containers until ready for use.
   3. Deliver aggregate to mixing site and handle in such manner that variations in moisture content will not interfere with steady production of concrete of specified degree of uniformity and slump.

B. Acceptance at Site: Reject material containers or materials showing evidence of water or other damage.

1.07 PROJECT CONDITIONS

A. Environmental requirements:
   1. Hot weather concreting (ACI 305):
      a. When ambient air temperature is above 90 degrees Fahrenheit: Prior to placing concrete, cool forms and reinforcing steel to by water cooling to below 90 degrees Fahrenheit.
      b. Temperature of concrete mix at time of placement: Keep temperature below 90 degrees Fahrenheit by methods which do not impair quality of concrete.
      c. For conditions that promote rapid drying, such as low humidity, high temperature, and wind, take corrective measures to reduce rapid water loss.
   2. Cold weather concreting:
      a. Concrete placed below ambient air temperature of 45 degrees Fahrenheit and falling or below 40 degrees Fahrenheit: Make provision for heating water.
      b. If materials have been exposed to freezing temperatures to degree that any material is below 35 degrees Fahrenheit: Heat such materials.
      c. Heating water, cement, or aggregate materials:
         1) Do not heat in excess of 160 degrees Fahrenheit.
      d. Protection of concrete in forms:
         1) Protect by means of covering with tarpaulins, or other acceptable covering acceptable to ENGINEER.
         2) Provide means for circulating warm moist air around forms in manner to maintain temperature of 50 degrees Fahrenheit for at least 5 days.
   3. For conditions that promote rapid drying of freshly placed concrete such as low humidity, high temperature, and wind: Take corrective measures to minimize rapid water loss from concrete:
      a. Furnish and use sufficient number of maximum and minimum self-recording thermometers to adequately measure temperature around concrete.

1.08 SEQUENCING AND SCHEDULING

A. Schedule placing of concrete in such manner as to complete any single placing operation to construction or expansion joint.

PART 2 PRODUCTS

2.01 MATERIALS

A. Admixtures:
   1. General:
      a. Do not use admixtures of any type, except as specified, unless written authorization has been obtained from the ENGINEER.
      b. Compatible with concrete and other admixtures.
      c. Do not use admixtures containing chlorides calculated as chloride ion in excess of 0.5 percent by weight.
      d. Use in accordance with manufacturer's recommendations and add each admixture to concrete mix separately.
   2. Pozzolan admixture:
      a. Fly ash in accordance with requirements of ASTM C 618, Class F, may be used as admixture in concrete made with Type II portland cement. Type C will not be permitted anywhere on this site.
      b. Maximum of 25 percent by weight of pozzolan admixture to total weight of cementitious materials. The total weight of cementitious materials shall not be less than minimum cementitious materials listed in Table A.
      c. Do not use pozzolan admixture as an admixture in concrete made with portland-pozzolan cement.
      d. Loss on Ignition for Pozzolan Admixture: Not exceed 4 percent.
   3. Water reducing admixture:
      a. May be used at the CONTRACTOR's option.
      b. Conform to ASTM C 494, Type A or Type D.
      c. Not contain air entraining agents.
      d. Liquid form before adding to the concrete mix.
      e. No decrease in cement is permitted as result of use of water reducing admixture.
      f. Eucon WR75 or WR91 by Euclid, Pozzolith 322N by Master Builders (BASF), or Plastocrete 160 by Sika.
   4. High range water reducing admixtures shall comply with ASTM C494, Type F or G, and shall only be used if included in submitted mix designs. Approved admixtures are Eucon SPC or Plastol Series by Euclid, Rheobuild 1000 or Glenum Series by BASF, or Daracem 100 or ADVA Flow Series by Grace.

B. Aggregate:
   1. General:
      a. Provide concrete aggregates that are sound, uniformly graded, and free of deleterious material in excess of allowable amounts specified.
      b. Grade aggregate in accordance with ASTM C 136 and D 75.
      c. Provide unit weight of fine and coarse aggregate that produces in place concrete with weight of not less than 140 pounds per cubic foot.

d. Do not use aggregate made from recycled materials such as crushed and screened hydraulic-cement concrete, brick, and other construction materials.

2. Fine aggregate:
   a. Provide fine aggregate for concrete or mortar consisting of clean, natural sand or of sand prepared from crushed stone or crushed gravel.
   b. Do not provide aggregate having deleterious substances in excess of following percentages by weight of contaminating substances. In no case shall total exceed percent listed.

Item	Test Method	Percent
Removed by decantation (dirt, silt, etc.)	ASTM C 117	3
Shale or Chert	ASTM C 295	1
Clay Lumps	ASTM C 142	1

   c. Except as otherwise specified, grade fine aggregate from coarse to fine in accordance with requirements of ASTM C 33.

3. Coarse aggregate:
   a. General: Provide coarse aggregate consisting of gravel or crushed stone made up of clean, hard, durable particles free from calcareous coatings, organic matter, or other foreign substances.
   b. Weight: Not exceeding 15 percent, for thin or elongated pieces having length greater than 5 times average thickness.
   c. Deleterious substances: Not in excess of following percentages by weight, and in no case having total of all deleterious substances exceeding 2 percent.

Item	Test Method	Percent
Shale or chert	ASTM C 295	1
Coal and lignite	ASTM C 123	1/4
Clay lumps and friable particles	ASTM C 142	1/4
Materials finer than Number 200 sieve	ASTM C 117	1/2*
* Except when material finer than Number 200 sieve consists of crusher dust, maximum amount shall be 1 percent.		

   d. Grading:
      1) Aggregate for Class A, B, C, and D concrete: As specified in ASTM C 33, Size Number 57, except as otherwise specified or authorized in writing by the ENGINEER.
      2) Aggregate for Class CE concrete for encasement of electrical conduits:
         a) Graded as specified in ASTM C 33, Size Number 8.

C. Concrete sealer:
   1. Manufacturers: One of the following or equal:
      a. ChemMasters, Madison, OH, Spray-Cure & Seal 25.
      b. Tamms Industries, Luster Seal WB-300.

D. Conduit encasement coloring agent:
   1. Color: Red color concrete used for encasement of electrical ducts, conduits, and similar type items.

2. Manufacturers: One of the following or equal:
   a. Davis Company, #100 Utility Red.
   b. I. Reiss Company, Inc., equivalent product.
   c. Euclid Colorcrete brick red.
3. Conduit encasement concrete: Mix into each cubic yard of concrete 10 pounds of coloring agent.

E. Evaporation retardant:
1. Manufacturers: One of the following or equal:
   a. Master Builders Technologies, Cleveland, Ohio, Confilm.
   b. Euclid Chemical Company, Cleveland, Ohio, Eucobar.

F. Keyway material: Steel, plastic, or lumber.

G. Nonslip abrasive:
1. Type: Aluminum oxide abrasive of size 8/16, having structure of hard aggregate, homogenous, nonglazing, rustproof, and unaffected by freezing, moisture, or cleaning compounds.
2. Manufacturers: One of the following or equal:
   a. Exolon Company, Tonawanda, New York.
   b. Abrasive Materials, Incorporated, Hillsdale, Michigan.

H. Portland cement:
1. General: Conform to specifications and tests for ASTM C 150, Types II or III, low alkali, except as specified otherwise.
2. Low alkali portland: Have total alkali containing not more than 0.60 percent.
3. Exposed concrete in any individual structure: Use only one brand of portland cement.
4. Cement for finishes: Provide cement from same source and of same type as concrete to be finished.

I. Plastic membrane curing: Use polyethylene film in accordance with ASTM C 171:
1. Color: White.
2. Thickness: Nominal thickness of polyethylene film shall not be less than 0.0040 inches when measured in accordance with ASTM D 2103. Thickness of polyethylene film at any point shall not be less than 0.0030 inches.
3. Loss of moisture: Not exceed 0.055 grams per square centimeter of surface when tested in accordance with ASTM C 156.

J. Sprayed membrane curing compound: Clear type with fugitive dye conforming to ASTM C 309, Type 1D.

K. Surface sealant system: Manufacturers: One of the following or equal:
1. Radcon Laboratories, Inc., Las Vegas, Nevada, Formula Number 7.
2. IPA Systems, Philadelphia, Pennsylvania, Duripal.

L. Water:
1. Water for concrete, washing aggregate, and curing concrete: Clean and free from oil and deleterious amounts of alkali, acid, organic matter, or other substances.

2. Chlorides and sulfate ions:
   a. Water for conventional reinforced concrete: Use water not containing more than 1,000 milligrams per liter of chlorides calculated as chloride ion, nor more than 1,000 milligrams per liter of sulfates calculated as sulfate ion.
   b. Water for prestressed or post-tensioned concrete: Use water not containing more than 650 milligrams per liter of chlorides calculated as chloride ion, nor more than 800 milligrams per liter of sulfates calculated as sulfate ion.

M. Shrinkage reducing admixture:
   1. Eucon SRA by Euclid or Eclypse by W.R. Grace.

2.02 EQUIPMENT

A. Mixing concrete:
   1. Mixers may be of stationary plant, paver, or truck mixer type.
   2. Provide adequate equipment and facilities for accurate measurement and control of materials and for readily changing proportions of material.
   3. Mixing equipment:
      a. Capable of combining aggregates, cementitious materials, and water within specified time into thoroughly mixed and uniform mass and discharging mixture without segregation.
      b. Maintain concrete mixing plant and equipment in good working order and operated at loads, speeds, and timing recommended by manufacturer or as specified.
      c. Proportion cementitious materials and aggregate by weight.

B. Machine mixing:
   1. Batch plant shall be capable of controlling delivery of all material to mixer within 1 percent by weight of individual material.
   2. If bulk cementitious materials are used, weigh them on separate visible scale which will accurately register scale load at any stage of weighing operation from zero to full capacity.
   3. Prevent cementitious materials from coming into contact with aggregate or with water until materials are in mixer ready for complete mixing with all mixing water.
   4. Procedure of mixing cementitious materials with sand or with sand and coarse aggregate for delivery to project site, for final mixing and addition of mixing water will not be permitted.
   5. Retempering of concrete will not be permitted.
   6. Discharge entire batch before recharging.
   7. Volume of mixed material per batch: Not exceed manufacturer's rated capacity of mixer.
   8. Mixers:
      a. Perform mixing in batch mixers of acceptable type.
      b. Equip each mixer with device for accurately measuring and indicating quantity of water entering concrete, and operating mechanism such that leakage will not occur when valves are closed.

c. Equip each mixer with device for automatically measuring, indicating, and controlling time required for mixing.

C. Transit-mixed concrete:
1. Mix and deliver in accordance with ASTM C 94.
2. Total elapsed time between addition of water at batch plant and discharging completed mix: Not to exceed 90 minutes. Elapsed time at project site shall not exceed 30 minutes.
3. Under conditions contributing to quick setting, total elapsed time permitted may be reduced by the ENGINEER.
4. Equip each truck mixer with device interlocked to prevent discharge of concrete from drum before required number of turns and furnish such device that is capable of counting number of revolutions of drum.
5. Continuously revolve drum after it is once started until it has completely discharged its batch.
   a. Do not admit water until drum has started revolving.
   b. Right is reserved to increase required minimum number of revolutions or to decrease designated maximum number of revolutions allowed, if necessary, to obtain satisfactory mixing. The CONTRACTOR will not be entitled to additional compensation because of such increase or decrease.

D. Other types of mixers: In case of other types of mixers, mixing shall be as follows:
1. Mix concrete until there is uniform distribution of materials, and discharge mixer completely before recharging.
2. Neither speed nor volume loading of mixer shall exceed manufacturer's recommendations.
3. Continue mixing for minimum of 1-1/2 minutes after all materials are in drum, and for batches larger than one cubic yard increase minimum mixing time 15 seconds for each additional cubic yard or fraction thereof.

2.03 MIXES

A. Measurements of materials:
1. Measure materials by weighing, except as otherwise specified or where other methods are specifically authorized in writing by the ENGINEER.
2. Furnish apparatus for weighing aggregates and cementitious materials that is suitably designed and constructed for this purpose.
3. Accuracy of weighing devices: Furnish devices that have capability of providing successive quantities of individual material that can be measured to within 1 percent of desired amount of that material.
4. Measuring or weighing devices: Subject to review by the ENGINEER. Shall bear valid seal of the Sealer of Weights and Measures having jurisdiction.
5. Weighing cementitious materials:
   a. Weigh cementitious materials separately.
   b. Cement in unbroken standard packages (sacks): Need not be weighed.
   c. Bulk cementitious materials and fractional packages: Weigh such cementitious materials.
6. Mixing water: Measured by volume or by weight.

B. Concrete proportions and consistency:
   1. Concrete consistency and composition:
      a. Provide concrete that can be worked readily into corners and angles of forms and around reinforcement without excessive vibration and without permitting materials to segregate or free water to collect on surface.
      b. Prevent unnecessary or haphazard changes in consistency of concrete.
   2. Ratio of coarse aggregate to fine aggregate: Not less than 1.0 or more than 2.0 for all concrete Classes, with exception of Class CE.
   3. Aggregate:
      a. Obtain aggregate from source that is capable of providing uniform quality, moisture content, and grading during any single day's operation.
   4. Concrete mix water to cementitious materials ratio, minimum cementitious materials content, and slump range: Conform to values specified in Table A in this Section.
   5. Concrete batch weights: Control and adjust to secure maximum yield. At all times, maintain proportions of concrete mix within specified limits.
   6. Mix modification: If required, by the ENGINEER, modify mixture within limits set forth in this Section.

C. Concrete mixes:
   1. Proportioning of concrete mix: Proportion mixes based on required average on compressive strength f'_{cr}.
   2. Mixes:
      a. Adjusting of water: After acceptance, do not change mixes without acceptance by ENGINEER, except that at all times adjust batching of water to compensate for free moisture content of fine aggregate.
      b. Total water content of each concrete class: Not exceed those specified in Table A in this Section.
      c. Checking moisture content of fine aggregate: Furnish satisfactory means at batching plant for checking moisture content of fine aggregate.
   3. Change in mixes: Submit new mix design and undertake new trial batch and test program as specified in this Section.

D. Hand mixed concrete:
   1. Hand mix concrete only when acceptable to the ENGINEER.
   2. Prepare hand mixed concrete on watertight, level platform in batches not to exceed 1/3 cubic yard each.
   3. Aggregate:
      a. First, spread required amount of coarse aggregate on platform in an even and uniform layer. Then over coarse aggregate, spread proper proportion of fine aggregate.
      b. Depth of combined coarse and fine aggregate layers: Not be greater than 1 foot.
   4. Cementitious materials:
      a. First, evenly spread required quantity of cementitious materials over fine aggregate.
      b. Then turn entire batch with shovels at least 2 times before adding water.
   5. Water:
      a. Then uniformly sprinkle or spray proper amount of water over batched materials.
      b. Then turn with shovels not less than 3 times before concrete is removed from platform.

E. Classes of concrete:
   1. Provide concrete consisting of 5 classes, referred herein as Classes A, B, C, D, and CE as specified in this Section. Use where specified or indicated on the Drawings.
   2. Weight of concrete classes: Provide classes of concrete having minimum weight of 140 pounds per cubic foot.
   3. Class B concrete: Class B concrete may be substituted for Class A concrete, when high-early strength concrete is needed in areas specifically accepted by the ENGINEER and that do not require sulfate resistant concrete.
   4. Class C concrete: Class C concrete may be used for fill for unauthorized excavation, for thrust blocks and ground anchors for piping, for bedding of pipe, and where indicated on the Drawings.
   5. Class D concrete: Use Class D for precast concrete items.
   6. Class CE concrete: Use Class CE for electrical conduit encasements.
   7. All other concrete, unless specified or otherwise indicated on the Drawings: Use Class A concrete.

TABLE A
CONCRETE
WITHOUT AIR ENTRAINMENT

Class	Specified Compressive Strength f'_c at 28 Days (Pounds per Square Inch)	Maximum Water-to-Cementitious Materials Ratio	Minimum Cementitious Materials per Cubic Yard of Concrete by Weight (Pounds)	Slump Range (Inches)
A	4,000	0.45	564	2 to 4
B (Type III cement)	4,000	0.45	564	2 to 4
C	2,500	0.62	423	3 to 6
D	4,500	0.45	658	2 to 4
CE	2,500	0.62	564	3 to 6

   8. Pumped concrete: Provide pumped concrete that complies with all requirements of this Section.
   9. Do not place concrete with slump outside limits indicated in Table A.
   10. Classes:
      a. Classes A, C, D, and CE concrete: Make with Type II low alkali portland cement.
      b. Class B concrete: Make with Type III low alkali portland cement.
      c. Admixtures: Provide admixtures as specified in this Section.

2.04 SOURCE QUALITY CONTROL

A. Tests:
   1. Mix designs:
      a. Submit concrete mix designs with historical test data. Test data shall be no older than 6 months.
      b. After concrete mix designs have been approved by the ENGINEER and in lieu of historical data, trial batches shall be prepared.

2. Trial batches:
   a. After concrete mix designs have been accepted by ENGINEER, and in lieu of accepted historical data, have trial batches of the accepted Class A, Class B, and Class D concrete mix designs prepared by testing laboratory acceptable to the ENGINEER.
   b. Prepare trial batches using specified cementitious materials and aggregates proposed to be used for the Work.
   c. Prepare trial batches with sufficient quantity to determine slump, workability, consistency, and finishing characteristics, and to provide sufficient test cylinders.
   d. Test cylinders: Provide cylinders having 6-inch diameter by 12-inch length and that are prepared in accordance with ASTM C 31 for tests specified in this Section.
   e. Determine slump in accordance with ASTM C 143.
   f. Test cylinders from trial batch:
      1) Test 8 cylinders for compressive strength in accordance with ASTM C 39:
         a) Test 4 cylinders at 7 days and 4 at 28 days.
         b) Establish ratio between 7 day and 28 day strength for mix. Seven day strength may be taken as satisfactory indication of 28 day strength provided effects on concrete of temperature and humidity between 7 day and 28 day are taken into account.
      2) Average compressive strength of 4 test cylinders tested at 28 days: Equal to or greater than required average compressive strength f'_{cr} on which concrete mix design is based.
   g. If trial batch tests do not meet specified requirements for slump, strength, workability, consistency, and finishing, change concrete mix design proportions and, if necessary, source of aggregate. Make additional trial batches and tests until an acceptable trial batch is produced that meets requirements of this Section.
   h. Perform test batches and tests required to establish trial batches and acceptability of materials without change in Contract Price.
   i. Do not place concrete until the concrete mix design and trial batch have been accepted by ENGINEER.
3. Required average compressive strength:
   a. Determine required average compressive strength (f'_{cr}) for selection of concrete proportions for mix design, for each class of concrete, using calculated standard deviation and its corresponding specified compressive strength f'_c, in accordance with ACI 318 and ACI 350.
   b. When test records of at least 30 consecutive tests that span period of not less than 45 calendar days are available, establish standard deviation as described in ACI 318 and ACI 350 and as modified as follows herein.
   c. Provide test records from which to calculate standard deviation that represent materials, quality control procedures, and conditions similar to materials, quality control procedures, and conditions expected to apply in preparation of concrete for the Work.
   d. Provide changes in materials and proportions within test records that are more restricted than those for the Work.
   e. Specified compressive strength (f'_c) of concrete used in test records: Within 1,000 pounds per square inch of that specified for the Work.

f. When lacking adequate test records for calculation of standard deviation meeting requirements, determine required average compressive strength f'_{cr} from following Table B.

TABLE B	
Specified Compressive Strength f'_c (pounds per square inch)	**Required Average Compressive Strength f'_{cr} (pounds per square inch)**
Less than 3,000	f'_c + 1,000
3,000 to 5,000	f'_c + 1,200
Over 5,000	f'_c + 1,400

4. Pozzolan admixture:
   a. Sampling and testing:
      1) Sample and test pozzolan admixture in accordance with ASTM C 311.
5. Aggregate:
   a. Testing of concrete aggregate is at CONTRACTOR's expense.
   b. If there is change in aggregate source or if there is a significant change in aggregate quality from same source, submit new set of design mixes covering each class of concrete and prepare new trial batches.
   c. Sieves:
      1) Use sieves with square openings for testing grading of aggregates.
      2) Sieve Analyses: If sieve analyses indicate significant change in materials, the ENGINEER may require that new mix design and trial batch be submitted and accepted before further placing of concrete.
   d. Sample aggregate in accordance with ASTM C 136 and D 75.
   e. Fine aggregate:
      1) Provide fine aggregate that does not contain strong alkali nor organic matter which gives color darker than standard color when tested in accordance with ASTM C 40.
      2) Provide aggregate having soundness complying with requirements of ASTM C 33 when tested in accordance with ASTM C 88.
      3) Provide aggregate complying with reactivity requirements of ASTM C 33 when tested in accordance with ASTM C 289.
   f. Coarse aggregate:
      1) Soundness when tested in accordance with ASTM C 88: Have loss not greater than 10 percent when tested with sodium sulfate.
      2) Abrasion loss: Not exceed 45 percent after 500 revolutions when tested in accordance with ASTM C 131.
      3) Reactivity: Not exceed limits specified in Appendix of ASTM C 33 when tested in accordance with ASTM C 289.
   g. Portland cement:
      1) Determination Alkali Content: Determine by method set forth in ASTM C 114.

PART 3 EXECUTION

3.01 INSTALLATION

A. Liquid evaporation retardant: Under conditions which result in rapid evaporation of moisture from the surface of the concrete, immediately after the concrete has been screeded, coat the surface of the concrete with a liquid evaporation retardant. Apply the evaporation retardant again after each work operation as necessary to prevent drying shrinkage cracks. Conditions which result in rapid evaporation of moisture may include one or more of the following:
   1. Low humidity.
   2. Windy conditions.
   3. High temperature.

B. Surface sealant system: Apply as recommended by manufacturer published instructions. Where concrete continues to sweat or leak, apply additional coats of surface sealant until the sweating or leaks stop.

C. Joints and bonding:
   1. As far as practicable construct concrete work as monolith.
   2. Locations of construction, expansion, and other joints are indicated on the Drawings or as specified in this Section.
   3. Construction joints:
      a. Where construction joints are not indicated on the Drawings, provide construction joints in slabs and walls at intervals not greater than 35 feet.
      b. In order to preserve strength and watertightness of structures, make no other joints, except as authorized the ENGINEER.
      c. At construction joints, thoroughly clean concrete of laitance, grease, oil, mud, dirt, curing compounds, mortar droppings, or other objectionable matter by means of heavy sandblasting, and wash surfaces just prior to succeeding concrete placement.
      d. At horizontal joints: Immediately prior to resuming concrete placing operations, thoroughly spread bed of grout not less than 1/2-inch in thickness nor more than 1 inch in thickness over horizontal joint surfaces.
   4. Keyways in joints:
      a. Provide keyways in joints as indicated on the Drawings.
      b. Treat lumber keyway material with form release coating, applied in accordance with manufacturer's instructions.
   5. Take special care to ensure that concrete is well consolidated around and against waterstops and waterstops are secured in proper position.
   6. Cleaning of construction joints:
      a. Wash construction joints free of sawdust, chips, and other debris after forms are built and immediately before concrete or grout placement.
      b. Should formwork confine sawdust, chips, or other loose matter in such manner that it is impossible to remove them by flushing with water, use vacuum cleaner for their removal, after which flush cleaned surfaces with water.
      c. Provide cleanout hole at base of each wall and column for inspection and cleaning.
   7. Contraction, construction, and expansion joints:
      a. Constructed where and as indicated on the Drawings.

b. Waterstops, expansion joint material, synthetic rubber sealing compound, and other similar materials: As specified in Sections 03150 and 07900.

8. Repair of concrete: Where it is necessary to repair concrete by bonding mortar or new concrete to concrete which has reached its initial set, first coat surface of set concrete with epoxy bonding agent as specified in Section 03071.

D. Conveying and placing concrete:
   1. Convey concrete from mixer to place of final deposit by methods that prevent separation or loss of materials.
   2. Use equipment for chuting, pumping, and conveying concrete of such size and design as to ensure practically continuous flow of concrete at delivery end without separation of materials.
   3. Design and use chutes and devices for conveying and depositing concrete that direct concrete vertically downward when discharged from chute or conveying device.
   4. Keep equipment for conveying concrete thoroughly clean by washing and scraping upon completion of any day's placement.

E. Placing concrete:
   1. Place no concrete without prior authorization of the ENGINEER.
   2. Do not place concrete until:
      a. Reinforcement is secure and properly fastened in its correct position and loose form ties at construction joints have been retightened.
      b. Dowels, bucks, sleeves, hangers, pipes, conduits, anchor bolts, and any other fixtures required to be embedded in concrete have been placed and adequately anchored.
      c. Forms have been cleaned and oiled as specified.
   3. Placement of concrete in which initial set has occurred, or of retempered concrete, will not be permitted.
   4. Place no concrete during rainstorms or high velocity winds.
   5. Protect concrete placed immediately before rain to prevent water from coming in contact with such concrete or winds causing excessive drying.
   6. Keep sufficient protective covering on hand at all times for protection of concrete.
   7. After acceptance, adhere to proposed sequence of placing concrete, except when specific changes are requested and accepted by the ENGINEER.
   8. Notify the ENGINEER in writing of readiness, not just intention, to place concrete in any portion of the work:
      a. Provide this notification in such time in advance of operations, as the ENGINEER deems necessary to make final inspection of preparations at location of proposed concrete placing.
      b. Place forms, reinforcement, screeds, anchors, ties, and inserts in place before notification of readiness is given to the ENGINEER.
      c. Depositing concrete:
         1) Deposit concrete at or near its final position to avoid segregation caused by rehandling or flowing.
         2) Do not deposit concrete in large quantities in one place and work along forms with vibrator or by other methods.
         3) Do not drop concrete freely into place from height greater than 5 feet.
         4) Use tremies for placing concrete where drop is over 5 feet.
         5) Commence placement of concrete on slopes, at bottom of slope.

9. Place concrete in approximately horizontal layers not to exceed 24 inches in depth and bring up evenly in all parts of forms.
10. Continue concrete placement without avoidable interruption, in continuous operation, until end of placement is reached.
11. After placement begins, it should continue without significant interruption. Precautions should be planned and implemented to prevent any delay, between layers being placed, from exceeding 20 minutes.
12. If concrete is to be placed over previously placed concrete and more than 20 minutes have elapsed, then spread layer of grout not less than 1/2 inch in thickness nor more than 1 inch in thickness over surface before placing additional concrete.
13. Placement of concrete for slabs, beams, or walkways:
    a. If cast monolithically with walls or columns, do not commence until concrete in walls or columns has been allowed to set and shrink.
    b. Allow set time of not less than one hour for shrinkage.

F. Consolidating concrete:
1. Place concrete with aid of acceptable mechanical vibrators.
2. Thoroughly consolidate concrete around reinforcement, pipes, or other shapes built into the work.
3. Provide sufficiently intense vibration to cause concrete to flow and settle readily into place and to visibly affect concrete over radius of at least 18 inches.
4. Vibrators:
    a. Keep sufficient vibrators on hand at all times to vibrate concrete as placed.
    b. In addition to vibrators in actual use while concrete is being placed, have on hand minimum 1 spare vibrator in serviceable condition.
    c. Place no concrete until it has been ascertained that all vibrating equipment, including spares, are in serviceable condition.
5. Take special care to place concrete solidly against forms to leave no voids.
6. Take every precaution to make concrete solid, compact, and smooth, and if for any reason surfaces or interiors have voids or are in any way defective, repair such concrete in manner acceptable to the ENGINEER.

G. Footings and slabs on grade:
1. Do not place concrete on ground or compacted fill until subgrade is in moist condition acceptable to the ENGINEER.
2. If necessary, sprinkle subgrade with water not less than 6 or more than 20 hours in advance of placing concrete.
3. If it becomes dry prior to actual placing of concrete, sprinkle again, without forming pools of water.
4. Place no concrete if subgrade is muddy or soft.

H. Loading concrete:
1. Green concrete:
    a. No heavy loading of green concrete will be permitted.
    b. Green concrete is defined as concrete with less than 100 percent of the specified strength.
2. No backfill shall be placed against concrete walls, connecting slabs, or beams until the concrete has reached the specified strength.

3. Use construction methods, sequencing, and allow time for concrete to reach adequate strength to prevent overstress of the concrete structure during construction.

I. Curing concrete:
   1. General:
      a. Cure concrete by methods specified in this Section.
      b. Cure concrete minimum of 7 days.
      c. Cure concrete to be painted with water or plastic membrane.
      d. Do not use curing compound on concrete surfaces that are to receive paint or upon which any material is to be bonded.
      e. Water cure or plastic membrane cure concrete slabs that are specified to be sealed by concrete sealer.
      f. Cure other concrete by water curing or sprayed curing membrane at the CONTRACTOR's option.
      g. Floor slabs may be cured using plastic membrane curing.
   2. Water curing:
      a. Keep surfaces of concrete being water cured constantly and visibly moist day and night for period of not less than 7 days.
      b. Each day forms remain in place may count as 1 day of water curing.
      c. No further curing credit will be allowed for forms in place after contact has once been broken between concrete surface and forms.
      d. Do not loosen form ties during period when concrete is being cured by leaving forms in place.
      e. Flood top of walls with water at least 3 times per day, and keep concrete surfaces moist at all times during 7 day curing period.
   3. Sprayed membrane curing:
      a. Apply curing compound to concrete surface after repairing and patching, and within 1 hour after forms are removed.
      b. If more than 1 hour elapses after removal of forms, do not use membrane curing compound, but use water curing for full curing period.
      c. If surface requires repairing or painting, water cure such concrete surfaces.
      d. Curing compound:
         1) Do not remove curing compound from concrete in less than 7 days.
         2) Curing compound may be removed only upon written request by the CONTRACTOR and acceptance by the ENGINEER, stating what measures are to be performed to adequately cure structures.
         3) Take care to apply curing compound in area of construction joints. See that curing compound is placed within construction joint silhouette.
         4) After curing period is complete, remove curing compound placed within construction joint silhouette by heavy sandblasting prior to placing any new concrete.
         5) CONTRACTOR's option: Instead of using curing compound for curing of construction joints, such joints may be water cured.
         6) Apply curing compound by mechanical, power operated sprayer and mechanical agitator that will uniformly mix all pigment and compound.
         7) Apply compound in at least 2 coats.
         8) Apply each coat in direction 90 degrees to preceding coat.

9) Apply curing compound in sufficient quantity so that concrete has uniform appearance and that natural color is effectively and completely concealed at time of spraying.
10) Continue to coat and recoat surfaces until specified coverage is achieved and until coating film remains on concrete surfaces.
11) Thickness and coverage of curing compound: Provide compound having film thickness that can be scraped from surfaces at any and all points after drying for at least 24 hours.
12) The CONTRACTOR is cautioned that method of applying curing compound specified herein may require more compound than normally suggested by manufacturer of compound and also more than is customary in the trade.
13) Apply amounts specified herein, regardless of manufacturer's recommendations or customary practice, if curing compound is used in place of water curing.
14) If the CONTRACTOR desires to use curing compound other than specified curing compound, coat sample areas of concrete wall with proposed curing compound and also similar adjacent area with specified compound in specified manner for comparison:
    a) If proposed sample is not equal or better, in opinion of the ENGINEER, in all features, proposed substitution will not be allowed.
15) Prior to final acceptance of the work, remove, by sandblasting or other acceptable method, any curing compound on surfaces exposed to view, so that only natural color of finished concrete is visible uniformly over entire surface.

4. Plastic membrane curing:
   a. Polyethylene film may be used to cure slabs. Seal joints and edges with small sand berm.
   b. Install plastic membrane as soon as concrete is finished and can be walked on without damage.
   c. Keep concrete moist under plastic membrane.

3.02 CONCRETE FINISHING

A. Provide concrete finishes in accordance with Section 03366.

B. Edges of joints:
   1. Provide joints having edges as indicated on the Drawings.
   2. Protect wall and slab surfaces at edges against concrete spatter and thoroughly clean upon completion of each placement.

C. Concrete sealer:
   1. Floors and slabs to receive concrete sealer: As specified in DIVISION 9 on finish schedule.
   2. Floors and slabs to receive concrete sealer: As specified in DIVISION 9.
   3. Seal floors and slabs at CONTRACTOR's option:
      a. All floor slabs except for the following:
         1) Those indicated on the Drawings to receive seamless Floor surfacing.
         2) Any slabs which receive concrete or grout surfacing, in lieu of water or curing compound.

4. Apply concrete sealer:
    a. Apply concrete sealer at coverage rate not to exceed 300 square feet per gallon.
    b. Apply as soon as slab or floor will bear weight.
    c. Sealer:
        1) Before applying concrete sealer, sweep entire surface clean with very soft bristled brush that will not mark finish and remove any standing water.
        2) Apply concrete sealer with sprayer.
        3) Use of paint rollers or mop is not acceptable.
        4) Workmen shall wear flat soled shoes which will not mark or scar surface.
        5) Do not allow traffic on floors and slabs until concrete sealer has dried and hardened.

3.03 FIELD QUALITY CONTROL

A. Testing of concrete:
    1. During progress of construction, the CONTRACTOR will have tests made to determine whether the concrete, as being produced, complies with requirements specified.
    2. Tests will be performed in accordance with ASTM C 31, ASTM C 39, and ASTM C 172.
    3. The CONTRACTOR will make and deliver test cylinders to the laboratory and testing expense will be borne by the CONTRACTOR.
    4. Required number cylinders:
        a. Not less than 3 cylinder specimens, 6-inch diameter by 12-inch long, will be tested for each 150 cubic yards of each class of concrete with minimum of 3 three specimens for each class of concrete placed and not less than 3 specimens for each half day's placement.
        b. One cylinder will be broken at 7 days and 2 at 28 days.
    5. The CONTRACTOR shall:
        a. Test slump of concrete using slump cone in accordance with requirements of ASTM C 143.
        b. Furnish test equipment.
        c. Do not use concrete that does not meet specification requirements in regards to slump. Remove such concrete from project site.
        d. Test slump at the beginning of each placement, as often as necessary to keep slump within the specified range, and when requested to do so by the ENGINEER.
        e. Make provisions for and furnish concrete for test specimens, and provide manual assistance in preparing said specimens.
        f. Assume responsibility for care of and providing of curing conditions for test specimens in accordance with ASTM C 31.

B. Enforcement of strength requirement:
    1. Concrete is expected to reach higher compressive strength than that which is indicated in Table A as specified compressive strength f'_c.
    2. Strength Level of Concrete: Will be considered acceptable if following conditions are satisfied:
        a. Averages of all sets of 3 consecutive strength test results is greater or equal to specified compressive strength f'_c.

b. No individual strength test (average of 2 cylinders) falls below specified compressive strength f'_c by more than 500 pounds per square inch.
c. Whenever one, or both, of 2 conditions stated above is not satisfied, provide additional curing of affected portion followed by cores taken in accordance with ASTM C 42, ACI 318, and ACI 350 and comply with following requirements:
   1) If additional curing does not bring average of 3 cores taken in affected area to at least specified compressive strength f'_c, designate such concrete in affected area as defective.
   2) The ENGINEER may require the CONTRACTOR to strengthen defective concrete by means of additional concrete, additional reinforcement, or replacement of defective concrete, all of the CONTRACTOR's expense.

3.04 ADJUSTING

A. Repair of defective concrete:
   1. Remove and replace or repair defective work.
   2. Correct defective work as specified in this Article.
   3. Do not patch, repair, or cover defective work without inspection by the ENGINEER.
   4. Provide repairs having strength equal to or greater than specified concrete for areas involved.
   5. Preparation of concrete for repair:
      a. Make no repair until ENGINEER has accepted method for preparing surface for repair.
      b. Chip out and key imperfections in the work and make them ready for repair.
      c. Surfaces of set concrete to be repaired: First coat with epoxy bonding agent as specified in Section 03071.
   6. Methods of repair:
      a. Dry Pack Method:
         1) Use for holes having depth nearly equal to or greater than least surface dimension of hole, for cone-bolt holes, and for narrow slots cut for repair.
         2) Smooth holes: Clean and roughen by heavy sandblasting before repair.
      b. Mortar method of replacement:
         1) Use for holes too wide to dry pack and too shallow for concrete replacement.
         2) Comparatively shallow depressions, large or small, which extend no deeper than nearest surface reinforcement.
      c. Concrete replacement:
         1) Use when holes extend entirely through concrete section or when holes are more than 1 square foot in area and extend halfway or more through the section.

END OF SECTION

SECTION 03366

TOOLED CONCRETE FINISHES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Tooled concrete finishes.

1.02 QUALITY ASSURANCE

A. Mock-ups:
   1. Test panels for concrete finishes:
      a. CONTRACTOR's initial 100 square feet of preparation shall serve as test panels for F4 and F5 finishes and tie-hole repairs for review by ENGINEER.
      b. Accepted panels shall serve as standard of quality and workmanship for project.
   2. Prepare test panel showing horizontal and vertical joints proposed for project for review by the ENGINEER. Refer to finishes specified n this Section.
   3. Test panels indicating methods for making concrete repairs. Prepare test panels for proposed repairs at beginning of project for review by ENGINEER.

1.03 DELIVERY, STORAGE, AND HANDLING

A. Packing and shipping:
   1. Deliver and store packaged materials in original containers until ready for use.

PART 2 PRODUCTS

2.01 MIXES

A. Mortar mix for F4 finish: Consist of 1 part cement and 1-1/2 parts of fine sand passing Number 100 screen, mixed with enough water and emulsified bonding agent to have consistency of thick cream.

PART 3 EXECUTION

3.01 CONCRETE FINISHING

A. Cement for finishes:
   1. Addition of white cement may be required to produce finish which matches color of concrete to be finished.

B. Vertical concrete surfaces: Use following finishes for vertical concrete surfaces as indicated in Article 3.02.
   1. F1 finish: No special treatment other than repair defective work and fill depressions 1 inch or deeper and tie holes with mortar after removal of curing membrane.
   2. F2 finish: No special treatment other than repair defective work, remove fins, fill depressions 1/2-inch or deeper and tie holes with mortar after removal of curing membrane.
   3. F3 finish: Repair defective work, remove fins, offsets, and curing membrane, and grind projections smooth. Fill depressions 1/4-inch or larger in depth or width and tie holes with mortar after removal of curing membrane.
   4. F4 finish:
      a. Same as specified for F3 finish, and, in addition fill depressions and holes 1/16 inch or larger in width with mortar.
      b. "Brush-off" sandblast surfaces prior to filling holes to expose all holes near surface of the concrete.
      c. Thoroughly wet surfaces and commence filling of pits, holes, and depressions while surfaces are still damp.
      d. Perform filling by rubbing mortar over entire area with clean burlap, sponge rubber floats, or trowels.
      e. Do not let any material remain on surfaces, except that within pits and depressions.
      f. Wipe surfaces clean and moist cure.

C. Horizontal concrete: After proper and adequate vibration and tamping, use following finishes for horizontal concrete surfaces as indicated in Article 3.02.
   1. S1 finish: Screeded to grade and leave without special finish.
   2. S2 finish: Smooth steel trowel finish.
   3. S3 finish: Steel trowel finish free from trowel marks. Provide smooth finish free of all irregularities.
   4. S4 finish: Steel trowel finish, without local depressions or high points, followed by light hairbroom finish. Do not use stiff bristle brooms or brushes. Perform brooming parallel to slab-drainage. Provide resulting finish that is rough enough to provide nonskid finish. Finish shall be subject to review and acceptance by the ENGINEER.
   5. S5 finish: Nonslip abrasive: After concrete has been screeded level and hardened enough to support man standing on a board, sprinkle abrasive from shake screen into surface at uniform rate of 25 pounds for each 100 square feet of surface area, wood float into finish, then trowel abrasive into surface with steel trowel properly exposing abrasive in surface as required to provide nonslip surface.

D. Concrete floor surfaces to which surfacing material is applied: Finish smooth with tolerance within 1/8-inch in 10 feet in any direction from lines indicated on the Drawings.

3.02 CONCRETE FINISHING

A. Finish concrete surfaces as indicated on the Drawings. Where not specified or indicated on the Drawings, finish surfaces as follows:
   1. F4 finish for following vertical surfaces: Concrete surfaces specified or indicated to be painted.

2. Surfaces in open channels, basins, and interior/exterior structures exposed to view: F3 finish.
3. F2 finish: All other.
4. S1 finish for following surfaces:
   a. Basin bottoms to which layer of grout is to be applied.
   b. Projecting footings which are to be covered with dirt.
   c. Slab surfaces which are to be covered with concrete fill.
5. S2 finish for following surfaces:
   a. Tops of corbels.
   b. Tops of walls and beams not covered above in this Section.
   c. Tops of slabs not covered above in this Section.
   d. All other surfaces not specified to be finished otherwise.
6. S3 finish for following surfaces:
   a. Building and machine room floors which are not covered with surfacing material: Provide floors that are free from trowel marks.
7. S4 finish for following surfaces:
   a. Exterior walkways.
   b. Tops of exterior walls or beams which are to serve as walkways.
   c. Tops of exterior walls or beams which are to support gratings.
   d. Slabs which will receive rubber tire truck traffic.
8. S5 finish: Slabs which will receive steel castor-wheeled container traffic, applied 6 feet either side of the centerline of travel, or either side of embedded plates shown on the Drawings.

END OF SECTION

SECTION 03600

GROUTS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Concrete mortar.
   2. Dry-pack mortar.
   3. Grout.
   4. Non-shrink grout.

B. Related sections:
   1. The Contract Documents are complementary; what is called for by one is as binding as if called for by all.
   2. It is the CONTRACTOR's responsibility for scheduling and coordinating the Work of subcontractors, suppliers, and other individuals or entities performing or furnishing any of CONTRACTOR's Work.
   3. The following sections are related to the Work described in this Section. This list of related sections is provided for convenience only and is not intended to excuse or otherwise diminish the duty of the CONTRACTOR to see that the completed Work complies accurately with the Contract Documents.
      a. Section 03071 - Epoxies.

1.02 REFERENCES

A. ASTM International (ASTM):
   1. C 109 - Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (using 2-inch or 50-millimeter cube specimens).
   1. C 230 - Standard Specification For Flow Table For Use In Tests Of Hydraulic Cement.
   2. C 531 - Standard Test Method for Liner Shrinkage and Coefficient of Thermal Expansion of Chemical-Resistant Mortars, Grouts, Monolithic Surfacings, and Polymer Concretes.
   3. C 939 - Standard Test Method for Flow of Grout for Preplaced-Aggregate Concrete (Flow Cone Method).
   4. C 1107 - Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Non-Shrink).

1.03 SUBMITTALS

A. Non-shrink grout: Submit manufacturer's literature and certified test data prior to installation.

1.04 DELIVERY, STORAGE, AND HANDLING

A. All materials shall be delivered to the jobsite in their original, unopened packages or containers, clearly labeled with the manufacturer's product identification and printed instructions.

B. All materials shall be stored in a cool dry place and in accordance with the manufacturer's recommendations.

C. All materials shall be handled in accordance with the manufacturer's instructions.

1.05 PROJECT/SITE CONDITIONS

A. Refer to manufacturer's literature or contact the manufacturer for any special physical or environmental limitations that may be required for use of products.

1.06 WARRANTIES

A. Non-shrink grout: The manufacturer shall warranty that the non-shrink grout will never go below its initial placement volume when tested in accordance with ASTM C 1107.

PART 2 PRODUCTS

2.01 MATERIALS

A. Concrete mortar:
   1. General: Consist of concrete mixture with coarse aggregate removed and water quantity adjusted as required.
   2. At exposed concrete surfaces not to be painted or submerged in water: White cement.

B. Dry-pack mortar:
   1. Consist of mixture of portland cement and sand.

C. Grout:
   1. Consist of mixture of portland cement and sand.

D. Non-shrink grout:
   1. Manufacturers: One of the following or equal:
      a. Five Star Products, Inc., Fairfield, CT, Five Star Grout.
      b. Master Builders, Inc., Cleveland, OH, Masterflow 928.
      c. L&M Construction Chemicals, Inc., Omaha, NE, CRYSTEX.
   2. Preportioned and prepackaged cement-based mixture. It shall contain no metallic particles such as aluminum powder and no metallic aggregate such as iron filings. It shall require only the addition of potable water.
   3. Potable water for pre-soaking, mixing, and curing: Clean and free of oils, acids, alkalies, organics, and any other deleterious matter.
   4. Bleeding: Free from the emergence of mixing water from within or the presence of water on its surface.
   5. In accordance with ASTM C 1107.
   6. Consistency: Remain at a minimum flowable consistency for at least 45 minutes after mixing at 45 degrees Fahrenheit to 90 degrees Fahrenheit when tested in accordance with ASTM C 230. If at a fluid consistency, it shall be verified in accordance with ASTM C 939.
   7. Dimensional stability (height change): In accordance with ASTM C 1107, volume-adjusting Grade B or C at 45 degrees to 90 degrees. It shall show 90 percent or greater bearing area under bases or baseplates.

8. Compressive strength: Non-shrink grout shall show minimum compressive strengths at 45 degrees Fahrenheit to 90 degrees Fahrenheit in accordance with ASTM C 1107 for various periods from the time of placement, including 5,000 pounds per square inch at 28 days when tested in accordance with ASTM C 109 as modified by ASTM C 1107.

2.02 MIXES

A. Concrete mortar mix:
   1. Use water-to-cementitious materials ratio that is no more than that specified for concrete being repaired.
   2. At exposed concrete surfaces not to be painted or submerged in water: Use sufficient white cement to make color of finished patch match that of surrounding concrete.

B. Dry-pack mortar mix: Use only enough water so that resulting mortar will crumble to touch after being formed into ball by hand.

C. Grout mix:
   1. For concrete repair: Mix in same proportions used for concrete being repaired, with only sufficient water to give required consistency for spreading.
   2. For spreading over the surfaces of construction or cold joints: Mix with no more water used than allowed by water-to-cementitious materials ratio specified for concrete.
   3. For other applications: Mix in proportions by weight of 1 part cement to 4 parts of concrete sand.

D. Non-shrink grout: Mix in accordance with manufacturer's installation instructions such that resulting mix has flowable consistency and is suitable for placing by pouring.

PART 3 EXECUTION

3.01 EXAMINATION

A. Inspect concrete surfaces to receive grout or mortar and verify that they are free of ice, frost, dirt, grease, oil, curing compounds, paints, impregnations, and all loose material or foreign matter likely to affect the bond or performance of grout or mortar.

B. Inspect baseplate and anchor systems for rust, oil, and other deleterious substances that may affect the bond or performance of grout.

C. Confirm that newly placed concrete has been cured sufficiently to attain its design strength and limit further shrinkage.

D. Verify that temperature of cementitious or epoxy grout does not exceed manufacturer's recommendations.

3.02 PREPARATION

A. Surface preparation:
   1. Roughen all concrete surfaces by heavy sandblasting, chipping, or other mechanical means to assure bond. Loose or broken concrete shall be removed.
   2. All grease, oil, dirt, curing compounds, laitance, and other deleterious materials that may affect bond that were identified in the inspection process shall be completely removed from concrete and bottoms of baseplates. All metal surfaces should have a 2 to 3 mil peak-to-valley profile for epoxy grouts.
   3. For cementitious mortars and grouts, concrete shall be saturated surface damp. Any standing water shall be removed prior to placing grouts.
   4. For epoxy grouts, do not wet concrete surfaces with water. Instead, where required, wet surfaces with epoxy for horizontal work or epoxy gel for vertical or overhead work prior to placing epoxy grouts.

B. Forms and headboxes for cementitious or epoxy grouts:
   1. Forms for grouts shall be built of material with adequate strength to withstand the placement of grouts.
   2. Forms must be rigid and liquid tight. All cracks and joints shall be caulked with an elastomeric sealant. All forms shall be lined with polyethylene for easy grout release. Forms carefully waxed with two coats of heavy-duty paste wax shall also be acceptable.
   3. Forms shall be 4 to 6 inches higher than the baseplate on one side of the baseplate configuration when using head pressure for placement.
   4. A sufficient number of headboxes shall be built to facilitate placement of grouts.
   5. Air relief holes a minimum 1/8-inch in diameter shall be provided when required by a baseplate configuration to avoid entrapping air underneath.

3.03 APPLICATION

A. Cement mortar and grout:
   1. For defective concrete repair:
      a. Filling: Filling of voids around items through the concrete.
      b. Grout spreading: Spread over construction joints, cold joints, and similar type items.
   2. Concrete surfaces:
      a. Apply epoxy-bonding agent to clean, roughened, and dry surfaces before placing mortar or grout.
   3. Placing:
      a. Exercise particular care in placing Portland cement mortar or grout since they are required to furnish structural strength, or impermeable water seal, or both.
      b. Do not use cement mortar or grout that has not been placed within 30 minutes after mixing.

3.04 PLACEMENT

A. The CONTRACTOR shall make arrangements to have a grout manufacturer's representative present for a preconstruction meeting and during initial grout placement.

B. Grout shall only be installed after the final equipment alignment is correct and accepted by the ENGINEER:
   1. Grouts shall be mixed in accordance with the manufacturer's recommendations.
   2. Use mortar mixer with moving paddles for mixing grouts. For cementitious grouts, pre-wet the mixer and empty out excess water before beginning mixing.
   3. Add non-shrink cementitious grout to a premeasured amount of water that does not exceed the manufacturer's maximum recommended water content.
   4. Mix cementitious grouts per manufacturer's instructions for uniform consistency.
   5. Grouts may be drypacked, flowed, or pumped into place. All baseplate grouting shall take place from one side of a baseplate to the other to avoid trapping air. Do not overwork grouts.
   6. Do not retemper grout by adding more water after stiffening.
   7. Hydrostatic head pressure shall be maintained by keeping the level of the grout in the headbox above the bottom of the baseplate. The headbox should be filled to the maximum level and the grout worked down to top of baseplate.

3.05 CURING

A. Grouts must be cut back to the lower edge of baseplates after reaching initial set. Provide a 45-degree angle cut back.

B. Clean equipment and tools as recommended by the grout manufacturer.

C. Cure grouts in accordance with manufacturer's specifications and recommendations. Keep grout moist for a minimum of 3 days. The method needed to protect grouts will depend on temperature, humidity, and wind. Wet burlap, a soaker hose, sun shading, ponding, and, in extreme conditions, a combination of methods shall be employed.

D. Grouts shall be maintained above 40 degrees Fahrenheit until they have attained a compressive strength of 3,000 pounds per square inch, or above 70 degrees Fahrenheit for a minimum of 24 hours to avoid damage from subsequent freezing.

3.06 FIELD QUALITY CONTROL

A. Non-shrink cementitious grouts shall be tested by the CONTRACTOR for 24-hour compressive strength in accordance with ASTM C 109.

END OF SECTION

SECTION 05120

STRUCTURAL STEEL

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Structural steel shapes and plate.
   2. Fasteners:
      a. All thread rods.
      b. Anchor bolts.
      c. Assembly bolts.
      d. Concrete anchors.
      e. High strength all thread rods.
      f. High strength bolts.
      g. Powder actuated fasteners.
      h. Undercut concrete anchors.
   3. Isolation sleeves and washers.
   4. Thread coating.
   5. Welding.

B. Related sections:
   1. The Contract Documents are complementary; what is called for by one is as binding as if called for by all.
   2. It is the CONTRACTOR's responsibility for scheduling and coordinating the Work of subcontractors, suppliers, and other individuals or entities performing or furnishing any of CONTRACTOR's Work.
   3. The following sections are related to the Work described in this Section. This list of related sections is provided for convenience only and is not intended to excuse or otherwise diminish the duty of the CONTRACTOR to see that the completed Work complies accurately with the Contract Documents.
      a. Section 01455 - Special Tests and Inspections.
      b. Section 03055 - Epoxy Bonding Reinforcing Bars and All Thread Rods In Concrete.
      c. Section 09960 - Coatings.

1.02 REFERENCES

A. American Institute of Steel Construction (AISC):
   1. Specification for Structural Steel Buildings.

B. American National Standards Institute (ANSI):
   1. B212-15 - Cutting Tools - Carbide-tipped Masonry Drills and Blanks for Carbide-Tipped Masonry Drills.

C. American Welding Society (AWS):
   1. A 5.1 - Specification for Carbon Steel Electrodes for Shielded Metal Arc Welding.

2. A 5.17 - Specification for Carbon Steel Electrodes and Fluxes for Submerged Arc Welding.
3. A 5.20 - Specification for Carbon Steel Electrodes for Flux Cored Arc Welding.
4. D 1.1 - Structural Welding Code - Steel.
5. D 10.4 - Recommended Practices for Welding Austenitic Chromium-Nickel Stainless Steel Piping and Tubing.

D. ASTM International (ASTM):
1. A 36/A 36M - Standard Specification for Carbon Structural Steel.
2. A 53 - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded, and Seamless.
3. A 108 - Standard Specification for Steel Bars, Carbon, Cold Finished Standard Quality.
4. A 123 - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
5. A 153/A 153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
6. A 193 - Standard Specification for Alloy Steel and Stainless Steel Bolting Materials for High-Temperature Service and Other Special Purpose Applications.
7. A 240 - Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
8. A 276 - Standard Specification for Stainless Steel Bars and Shapes.
9. A 307 - Standard Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength.
10. A 325 - Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength
11. A 489 - Standard Specification for Carbon Steel Lifting Eyes.
12. A 490 - Standard Specification for Structural Bolts, Alloy Steel, Heat Treated, 150 ksi Minimum Tensile Strength.
13. A 496 - Standard Specification for Steel Wire, Deformed, for Concrete Reinforcement.
14. A 500 - Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.
15. A 501 - Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing.
16. A 992/A 992M - Standard Specification for Structural Steel Shapes.
17. F 593 - Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.
18. F 959 - Standard Specification for Compressible-Washer-Type Direct Tension Indicators for Use with Structural Fasteners.

E. International Code Council Evaluation Service, Inc. (ICC-ES):
1. AC01 – Acceptance Criteria for Expansion Anchors in Masonry Elements.
2. AC58 – Acceptance Criteria for Adhesive Anchors in Masonry Elements.
3. AC193 – Acceptance Criteria for Mechanical Anchors in Concrete Elements.
4. AC308 – Acceptance Criteria for Post-Installed Adhesive Anchors in Concrete Elements.

1.03 SUBMITTALS

A. Product data:
   1. Post-installed anchors for use in concrete and masonry.
      a. Manufacturer's data including catalog cuts showing materials of construction, finishes, and details of installation for each anchor type.

B. Quality control submittals:
   1. Submit shop drawings of members to be fabricated before starting their fabrication. Submittals shall be on size 30-inch x 42-inch drawings.
   2. Welder's certificates.
   3. Submit steel fabricator's certification.

C. Test reports:
   1. Certified copies of mill tests and analyses made in accordance with applicable ASTM standards, or reports from a recognized commercial laboratory, including chemical and tensile properties of each shipment of structural steel or part thereof having common properties.
   2. Current International Code Council ES Report for each type of post-installed anchors to be used.
   3. Concrete anchor installation test report.

1.04 QUALITY ASSURANCE

A. Qualifications:
   1. Perform welding of structural metals with welders who have current American Welding Society certificate for the type of welding to be performed.
   2. Notify ENGINEER 24 hours minimum before starting shop or field welding.
   3. ENGINEER may check materials, equipment, and qualifications of welders.
   4. Remove welders performing unsatisfactory Work, or require to requalify.
   5. ENGINEER may use gamma ray, magnetic particle, dye penetrant, trepanning, or other aids to visual inspection to examine any part of welds or all welds.
   6. CONTRACTOR shall bear costs of retests on defective welds.
   7. CONTRACTOR shall also bear costs in connection with qualifying welders.
   8. Special inspection by OWNER for the installation of chemical anchors as specified in Section 01455 is required.

B. Certification:
   1. Steel fabricators shall be certified by the American Institute of Steel Construction (AISC) or other certification acceptable to the local building official having jurisdiction.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Packing and shipping: Deliver structural steel free from mill scale, rust, and pitting.

B. Storage and protection: Until erection and painting, protect from weather items not galvanized or protected by a shop coat of paint.

PART 2 PRODUCTS

2.01 MATERIALS

A. Unless otherwise specified or indicated on the Drawings, materials shall conform to the following:

Item	ASTM Standard	Class, Grade, Type, or Alloy Number
Steel		
Plate, bars, rolled shapes, and miscellaneous items (except W and WT shapes)	A 36	--
Rolled W and WT shapes	A 992	Grade 50
Hollow structural sections (HSS), odd formed: round, square, or rectangular	A 500	Grade B
Tubing, hot-formed	A 501	--
Round HSS	A 500	Grade B
Steel pipe	A 53	Grade B
Stainless steel		
Plate, sheet, and strip	A 240	Type 304* or 316**
Bars and shapes	A 276	Type 304* or 316**
* Use Type 304L if material will be welded.		
** Use Type 316L if material will be welded.		

B. Where stainless steel is welded, use low-carbon stainless steel.

2.02 FASTENERS

A. General: Furnish threaded fasteners, except high strength bolts, with flat washers, and self-locking nuts, or lock washers and nuts:
   1. Bolt heads and nuts: Hex-type.
   2. Bolts, nuts, and washers: Of domestic manufacture.
   3. Where bolts, including anchor bolts, nuts, washers, and similar fasteners are specified to be galvanized, galvanize in accordance with ASTM A 153.

B. All thread rods:
   1. Type 316 stainless steel in accordance with ASTM F 593 for use in wet and moist locations, including:
      a. Water-containing structures:
         1) Below and at water level.
         2) Above water level:
            a) Below top of walls of water-containing structures.
            b) Under the roof, slab, beam, or walkway of enclosed water-containing structures.
         3) Dry side of walls of water-containing structures.
      b. Pump bases.

2. Type 304 or Type 316 stainless steel in accordance with ASTM F 593 for aluminum assemblies.
3. ASTM A 36 meeting the mechanical requirements of ASTM A 307. Hot-dip galvanize for galvanized assemblies and for applications other than those specified.

B. All thread rods bonded in holes drilled in concrete with epoxy: As specified in Section 03055 and as indicated on the Drawings.

C. Anchor bolts:
1. Anchor bolts, nuts, and washers: Type 316 stainless steel in accordance with ASTM F 593 for use in wet and moist locations, including:
   a. Water-containing structures:
      1) Below and at water level.
      2) Above water level:
         a) Below top of walls of water-containing structures.
         b) Under the roof, slab, beam, or walkway of enclosed water-containing structures.
      3) Dry side of walls of water-containing structures.
   b. Pump bases.
2. Anchor bolts, nuts, and washers: Type 304 or Type 316 stainless steel for fastening aluminum to concrete or steel.
3. Anchor bolts, nuts, and washers: Hot-dip galvanized ASTM A 307 steel bolt or hot-dip galvanized ASTM A 36 steel, for applications other than those specified.

D. Assembly bolts:
1. Type A-325 high strength bolts for structural steel connections.
2. Bolts, nuts, and washers for wood baffles, collectors, and other field-assembled construction: Type 316 stainless steel in accordance with ASTM F 593 for use in wet and moist locations, including:
   a. Water-containing structures:
      1) Below and at water level.
      2) Above water level:
         a) Below top of walls of water-containing structures.
         b) Under the roof, slab, beam, or walkway of enclosed water-containing structures.
         c) Dry side of walls of water-containing structures.
   b. Pump bases.
3. Type 304 or Type 316 stainless steel in accordance with ASTM F 593 for aluminum assemblies.
4. Hot-dip galvanized ASTM A 307 steel for galvanized assemblies and for applications other than those specified.

E. Concrete anchors:
1. Manufacturers: One of the following or equal:
   a. Hilti Incorporated, Kwik Bolt 3 Concrete Anchor.
   b. ITW Ramset/Redhead, Trubolt Wedge Concrete Anchor.
   c. Simpson Strong Tie, Wedge-All Concrete Anchors.

2. Concrete anchor's integral threaded stud, wedge, washer, and nut: Type 304 or Type 316 stainless steel in accordance with ASTM F 593. For use in wet and moist locations, including:
    a. Water-containing structures:
        1) Below and at water level.
        2) Above water level:
            a) Below top of walls of water-containing structures.
            b) Under the roof, slab, beam, or walkway of enclosed water-containing structures.
        3) Dry side of walls of water-containing structures.
    b. Pump bases.
3. Concrete anchor's integral threaded stud, wedge, washer, and nut: Type 304 or 316 stainless steel in accordance with ASTM F 593 for fastening aluminum to concrete or steel.
4. Concrete anchor's integral threaded stud, wedge, washer, and nut: Hot-dip galvanized carbon steel, for applications other than those specified.
5. Do not use slug-in, lead cinch, and similar systems relying on deformation of lead alloy or similar materials in order to develop holding power.

F. High strength all thread rods: in accordance with ASTM A 193, grade b7. Hot-dip galvanize.

G. High strength bolts: High strength bolts, nuts, and hardened flat washers shall be in accordance with ASTM A 325 or ASTM A 490, as indicated on the Drawings.

H. Powder actuated fasteners:
1. For Installation in Concrete or Steel: Zinc coated, heat-treated, alloy steel.
2. Fasteners Not Sufficiently Protected against Corrosion from Exposure to Corrosive Conditions: Coat as necessary to make suitable for such conditions.
3. Pins: Furnish with head or threaded stud capable of transmitting loads to shank.
4. Pins Connected to Steel: Furnish with longitudinal serrations around circumference of shank.

I. Undercut concrete anchors:
1. Materials: In accordance with ASTM A 193, Grade B7. Hot-dip galvanize.
2. Manufacturers: One of the following or equal:
    a. Covert Operations Incorporated, Long Beach, CA, DUC Undercut Anchors.
    b. Drillco Devices Limited, Long Island City, NY, Maxi-Bolt Bearing Type Undercut Anchors.

2.03 ISOLATING SLEEVES AND WASHERS

A. Manufacturers: One of the following or equal:
1. Central Plastics Company, Shawnee, Oklahoma.
2. Corrosion Control Products, PSI Inc., Gardena, CA.

B. Sleeves: Mylar, 1/32-inch thick, 4,000 volts per mil dielectric strength, of proper size to fit bolts and extending half way into both steel washers.
1. One sleeve required for each bolt.

C. Washers: The inside diameter of all washer shall fit over the isolating sleeve and both the steel and isolating washers shall have the same inside diameter and outside diameter:
   1. Proper size to fit bolts. Two insulating washers are required for each bolt.
   2. Two 1/8-inch thick steel washers for each bolt.
   3. G3 Phenolic:
      a. Thickness: 1/8-inch.
      b. Base Material: Glass.
      c. Resin: Phenolic.
      d. Water Absorption: 2 percent.
      e. Hardness (Rockwell): 100.
      f. Dielectric Strength: 450 volts per mil.
      g. Compression Strength: 50,000 pounds per square inch.
      h. Tensile Strength: 20,000 pounds per square inch.
      i. Maximum Operating Temperature: 350 degrees Fahrenheit.

2.04 GALVANIZED SURFACE REPAIR

A. Manufacturers: One of the following or equal:
   1. Galvinox.
   2. Galvo-Weld.

2.05 THREAD COATING

A. Manufacturers: One of the following or equal:
   1. Never Seez Compound Corporation, Never-Seez.
   2. Oil Research, Inc., WLR No. 111.

2.06 SUPPLEMENTARY PARTS

A. Furnish as required for complete structural steel erection, whether or not such parts and Work are specified or indicated on the Drawings.

2.07 FABRICATION

A. Shop assembly:
   1. Fabricate structural steel in conformance with AISC "Specification for the Structural Steel Buildings - Allowable Stress Design and Plastic Design," unless otherwise specified or modified by applicable regulatory requirements.
   2. Where anchors, connections, or other details of structural steel are not specifically indicated on the Drawings or specified, their material, size and form shall be equivalent in quality and workmanship to items specified.
   3. For structural members such as W shapes, S shapes, channels, angles, and similar members not available in quantity, size, and type of stainless steel specified or indicated on the Drawings:
      a. Fabricate by welding together pieces of low carbon stainless steel plate, such as Type 316L.
      b. Make full penetration welds between pieces of plate to attain same or higher section modulus and moment of inertia as members indicated on the Drawings.

4. Where galvanizing is required, hot-dip galvanize structural steel after fabrication in accordance with ASTM A 123:
   a. Do not electro-galvanize or mechanically-galvanize unless specified or accepted by ENGINEER.
   b. Restraighten galvanized items that bend or twist during galvanizing.
5. Round off sharp and hazardous projections and grind smooth.
6. Take measurements necessary to properly fit work in the field. Take responsibility for and be governed by the measurements and proper working out of all the details.
7. Take responsibility for correct fitting of all metal work.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verification of conditions: Examine Work in place to verify that it is satisfactory to receive the Work of this Section. If unsatisfactory conditions exist, do not begin this Work until such conditions have been corrected.

3.02 ERECTION

A. General:
   1. Fabricate structural and foundry items to true dimensions without warp or twist.
   2. Form welded closures neatly, and grind off smooth where weld material interferes with fit or is unsightly.
   3. Install structural items accurately and securely, true to level, plumb, in correct alignment and grade, with all parts bearing or fitting structure or equipment for which intended.
   4. Do not cock out of alignment, redrill, reshape, or force fit fabricated items.
   5. Place anchor bolts or other anchoring devices accurately and make surfaces that bear against structural items smooth and level.
   6. Rigidly support and brace structural items needing special alignment to preserve straight, level, even, and smooth lines. Keep structural items braced until concrete, grout, or dry pack mortar has hardened for 48 hours minimum.
   7. Erect structural steel in conformance with AISC "Specification for Structural Steel Buildings - Allowable Stress Design and Plastic Design," unless otherwise specified or modified by applicable regulatory requirements.
   8. Where anchors, connections, and other details of structural steel erection are not specifically indicated on the Drawings or specified, form, locate, and attach with equivalent in quality and workmanship to items specified.
   9. Round off sharp or hazardous projections and grind smooth.
   10. Paint or coat steel items as specified in Sections 09910 and 09960. Shop-applied surface preparation shall be as required for final coating in field.

B. Welding - general:
   1. Make welds full penetration type, unless otherwise indicated on the Drawings.
   2. Remove backing bars and weld tabs after completion of weld. Repair defective welds observed after removal of backing bars and weld tabs.

C. Welding stainless steel:
   1. General: Comply with AWS D1.1.
      a. Perform with electrodes and techniques in accordance with AWS D10.4.

D. Welding carbon steel:
   1. General: Comply with AWS D1.1.
      a. Weld ASTM A 36 and A 992 structural steel, ASTM A 500 and A 501 structural tubing, and ASTM A 53 pipe with electrodes conforming to AWS A5.1, using E70XX electrodes; AWS A5.17, using F7X-EXXX electrodes; or AWS A5.20, using E7XT-X electrodes:
         a) Field repair cut or otherwise damaged galvanized surfaces to equivalent original condition using a galvanized surface repair.

E. Interface with other products:
   1. Where steel fasteners come in contact with aluminum or other dissimilar metals, bolt with stainless steel bolts and separate or isolate from dissimilar metals with isolating sleeves and washers.
      1) Prior to installing nuts, coat threads of stainless steel fasteners with thread coating to prevent galling of threads.

F. Fasteners:
   1. General:
      a. Install bolts, including anchor bolts and concrete anchors, to project 2 threads minimum, but 1/2 inch maximum beyond nut.
      b. Unless otherwise specified, tighten bolts, including anchor bolts and concrete anchors, to the "snug-tight" condition, defined as tightness attained by a few impacts of an impact wrench or the full effort of a man using an ordinary spud wrench.
   2. All thread rods bonded in drilled holes in concrete with epoxy: As specified in Section 03055 and as indicated on the Drawings.
   3. Anchor bolts:
      a. Cast-in-place when concrete is placed.
      b. Accurately locate anchor bolts embedded in concrete with bolts perpendicular to surface from which they project.
      c. Do not allow anchor bolts to touch reinforcing steel.
      d. Where anchor bolts are within 1/4-inch of reinforcing steel, isolate with a minimum of 4 wraps of 10-mil polyvinyl chloride tape in area adjacent to reinforcing steel.
      e. In anchoring machinery bases subject to heavy vibration, use 2 nuts, with 1 serving as a locknut.
      f. Where bolts are indicated on the Drawings for future use, first coat thoroughly with nonoxidizing wax, then turn nuts down full depth of thread and neatly wrap exposed thread with waterproof polyvinyl tape.
      g. Furnish anchor bolts with standard hex bolt head or an equivalent head acceptable to ENGINEER unless otherwise indicated on the Drawings. "L" or "J" anchor bolts are not equivalent to an anchor bolt with a hex bolt head.
      h. Minimum anchor bolt embedment: 10-bolt diameters, unless longer embedment is indicated on the Drawings.
      i. Where indicated on the Drawings, set anchor bolts in metal sleeves having inside diameter approximately 2 inches greater than bolt diameter and minimum 10-bolt diameters long. Seal top of sleeve to prevent grout from filling sleeve.
      j. Anchor bolts may be cast in concrete in lieu of using concrete anchors.
   4. Concrete anchors:
      a. Do not use concrete anchors in lieu of anchor bolts.

b. Accurately locate concrete anchors and set perpendicular to surfaces from which they project.
c. Minimum embedment lengths:

Diameter Inches	Embedment Length Inches
1/4	2
3/8	2-1/2
1/2	4-1/8
5/8	4-1/2
3/4	6-1/2

d. Drilling holes:
   1) Do not damage or cut existing reinforcing bars, electrical conduits, or other items embedded in the existing concrete without acceptance by ENGINEER.
   2) Determine location of reinforcing bars, or other obstructions with a non-destructive indicator device.
   3) Remove dust and debris from hole using compressed air.
e. Hole drilling equipment:
   1) Electric or pneumatic rotary type with light or medium impact.
   2) Drill Bits: Carbide-tipped in accordance with ANSI B212-15.
   3) Hollow drills with flushing air systems are preferred.
   4) Where edge distances are less than 2 inches, use lighter impact equipment to prevent microcracking and concrete spalling during drilling process.

5. High strength bolts:
   a. Consider connections with high strength bolts to be slip critical structural connections, unless otherwise indicated on the Drawings.
   b. Connections with high strength bolts shall conform to AISC Specification for Structural Joints using ASTM A 325 or A 490 Bolts.
   c. Furnish hardened flat washer:
      1) Under element, nut, or bolt head, turned in tightening.
      2) On outer plies for short slotted holes.
   d. Verify adequate tightening of bolts by means of tension indicator washers placed as indicated in ASTM F 959, Figure 1.
6. Powder actuated fasteners: Use powder actuated fasteners only for applications indicated on the Drawings or specified.
7. Undercut anchors:
   a. Accurately locate concrete anchors and set perpendicular to surfaces from which they project.
   b. Drilling holes:
      1) Do not damage or cut existing reinforcing bars, electrical conduits, or other items embedded in the existing concrete without acceptance by ENGINEER.
      2) Determine location of reinforcing bars, or other obstructions with a non-destructive indicator device.
   c. Hole drilling equipment:
      1) Electric or pneumatic rotary type with light or medium impact.
      2) Drill bits: Carbide-tipped in accordance with ANSI B212-15.
      3) Hollow drills with flushing air systems are preferred.

4) Where edge distances are less than 2 inches, use lighter impact equipment to prevent microcracking and concrete spalling during drilling process.
5) Undercut bottom of hole using cutting tools manufactured for this purpose by undercut anchor manufacturer.

END OF SECTION

SECTION 06608

FIBERGLASS REINFORCED PLASTIC

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: General fabrication and design requirements for fiberglass reinforced plastic fabrications.

B. Related sections:
   1. The Contract Documents are complementary; what is called for by one is as binding as if called for by all.
   2. It is the CONTRACTOR's responsibility for scheduling and coordinating the Work of subcontractors, suppliers, and other individuals or entities performing or furnishing any of CONTRACTOR's Work.
   3. The following Sections are related to the Work described in this Section. This list of Related Sections is provided for convenience only and is not intended to excuse or otherwise diminish the duty of the CONTRACTOR to see that the completed Work complies accurately with the Contract Documents.
      a. Section 01410 - Regulatory Requirements.

1.02 REFERENCES

A. American Society of Mechanical Engineers (ASME):
   1. RTP-1 - Reinforced Thermoset Plastic Corrosion Resistant Equipment.

B. ASTM International (ASTM):
   1. C 582 - Standard Specification for Contact-Molded Reinforced Thermosetting Plastic (RTP) Laminates for Corrosion-Resistant Equipment.
   2. D 883 - Standard Terminology Relating to Plastics.
   3. D 2563 - Standard Practice for Classifying Visual Defects in Glass-Reinforced Plastic Laminate Parts.
   4. D 2583 - Standard Test Method for Indentation Hardness of Rigid Plastics by Means of a Barcol Impressor.
   5. D 2584 - Standard Test Method for Ignition Loss of Cured Reinforced Resins.
   6. D 3299 - Standard Specification for Filament-Wound Glass Fiber Reinforced Thermoset Resin Corrosion-Resistant Tanks.
   7. D 4097 - Standard Specification for Contact-Molded Glass-Fiber-Reinforced Thermoset Resin Corrosion-Resistant Tanks.

1.03 DEFINITIONS

A. The terminology of this specification is in accordance with ASTM D 883. Fabricators using this specification are responsible for correct interpretation.

B. Fiberglass reinforced plastic: Fiberglass Reinforced Plastic or glass fiber and resin fabrication consisting of approximately 35 to 55 percent glass fiber reinforcement by weight for hand lay-up structural laminates and 55 to 70 percent glass for filament wound structural laminates, unless otherwise specified.

C. Equipment: The fiberglass reinforced plastic equipment, including ancillary equipment, work, and materials as described in this specification.

D. Fabrication drawings: Those drawings produced by the Fabricator or CONTRACTOR, with the intention of providing the necessary information to construct or install the equipment.

E. Mat: Fibrous material consisting of randomly oriented chopped or swirled filaments loosely held together with a binder.

F. Chopped glass: Fibrous material consisting of randomly oriented chopped filaments applied directly to a mold surface or laminated under construction by a chopper gun.

G. Fiber prominence (jackstraw): The distinct visibility of individual glass strands causing a loss of translucency of the laminate.

1.04 DESIGN REQUIREMENTS

A. Design fiberglass reinforced plastic tanks, scrubbers, and other vessels following the procedures and methods, utilizing the equations and formulas, and incorporating safety factors and allowable design stresses and strains set forth in ASME RTP-1. Base the design of duct and other fiberglass reinforced plastic equipment not covered by ASME RTP-1 on the engineering rationale, applicable formulas, and safety factors set forth in ASME RTP-1.

B. Perform calculations necessary to ensure long-term, low risk service of the fiberglass reinforced plastic equipment with minimum reasonable maintenance requirements.
   1. Long-term, low risk service is defined as a service life of 20 years without major structural failure or leakage.
   2. The design shall ensure proper functioning of the equipment at the stated operating conditions.
   3. The design shall include as a minimum, engineering calculations, materials selection and documented physical and mechanical properties, and detailed drawings required for fabrication and assembly of the equipment.

C. Design in accordance with applicable national, regional, and local design and building codes.
   1. Wind and seismic forces shall be determined in accordance with the building code as specified in Section 01410.

D. Resistance to overturning shall not include the weight of the liquid contained in the equipment.

E. Consider the interaction of the installed system including but not limited to thermal expansion of duct, tanks, and vessels and the effects of external loading from piping, fans, pumps, platforms, and other attached items.

F. Allow for the most severe combination of conditions which may include, but not be limited to, the following:
   1. Internal or external pressure.
   2. Static head of contents (working and test conditions).
   3. Mass of structure and contents.

4. Design temperature including upset conditions.
5. Superimposed loads, such as seismic and wind forces.
6. Bending moments due to eccentric loads.
7. Localized loads acting at supports, lugs, and other attachments.
8. Shock loads.
9. Loads due to heating or cooling and thermal gradients.
10. Loads applied during transport or erection.
11. Loads imposed by personnel during erection and operations.
12. Fatigue.

G. Use safety factors and allowable strains specified in ASME RTP-1 unless otherwise specified. Do not use safety factors and allowable strains less than the following:
   1. Allowable hoop and axial strain shall be 0.001 inch per inch for filament wound tanks.
   2. A safety factor of 10 for hand lay-up components in tension, flexure, or other loading conditions where elastic stability is not in question.
   3. A safety factor of 5 for external loading (vacuum) or local buckling due to seismic or wind loading.

H. Safety factors for upset conditions or infrequent loading situations may be less than the above values for the specific condition if acceptable to the ENGINEER.

I. There will typically be other aspects which should be considered. Identify and consider their effects, identify design limitations, and submit this information.

J. Provide test reports or other documentation for laminate properties used in the design. Laminates shall be similar in construction, layer sequence, resin type, and cure to those used to determine tested properties. Properties shall be adjusted to reflect reductions at operating temperatures. Test reports shall be provided for:
   1. Grating: Indicate grating strength and deflection.
   2. Physical properties of test cover panels.
   3. Tanks showing conformance with specified strength requirements.

K. The corrosion liner shall be a minimum of 100 mils in thickness, unless otherwise specified, and documentation shall be provided verifying veil type, liner thickness, and resin cure.
   1. Consider 50 mils of the corrosion liner as sacrificial and do not include it in determining structural wall thickness.
   2. Use structural wall thickness not less than 0.375 inches for tanks and vessels and 0.1875 inches for ductwork.
   3. Submit minimum structural thicknesses of other types of fiberglass reinforced plastic fabrications.

L. Laminate types may include hand lay up, helical winding, and hoop/chop construction methods.
   1. In laminates with helix angles greater than 80 degrees and in hoop/chop laminates, orientate approximately 10 percent of the structural wall thickness at 0 degrees (longitudinal direction).
   2. Apply this reinforcement in at least 2 layers of weft unidirectional fabric and equally spaced within the structural wall.

M. For tanks and scrubbers; nozzles, determine manways and shell reinforcements according to the tables and formulas in ASME RTP-1.

N. Anchor tanks and vessels using lugs and a continuous filament wound band or an integral filament wound load ledge with external stainless steel anchor clips.
   1. The anchor clips shall be bolted to the concrete foundation; use non-shrink grout to level anchor clips.
   2. The design shall resolve the sum of the moments and the sum of the force equal to 0.

O. Design internal beams and support attachments using a maximum of 200 pounds per square inch shear stress for secondary bonds. Also apply this to design of external lugs required for ladders, platforms, and other attached items.

1.05 SUBMITTALS

A. Shop drawings and calculations:
   1. Submit general arrangement and fabrication drawings, calculations, and elements of the design.
   2. Include submittal information which describes specifically how the equipment is to be built and details necessary to ascertain that products meet specified requirements. Provide in the form of drawings, standards, specifications, or other shop instructions, but may also be partially contained in quality control records. The submittal shall include, but not be limited to:
      a. Fabrication drawings.
      b. General arrangement drawings signed by an ENGINEER registered in the state where the project is located, showing complete structural, fasteners, and erection procedures for a complete assembly.
      c. Quality control programs.
      d. Verification that the manufacturer has been engaged in fabrication of similar fiberglass reinforced plastic equipment for a minimum of 5 years.
      e. Statement of compliance with contract design requirements, codes, and standards.
      f. Recommendation for each resin selection from resin manufacturer.
      g. Type and amounts of fillers.
      h. Nominal corrosion liner description.
      i. Reinforcement types and glass content range for hand lay-up laminates.
      j. For filament wound laminates:
         1) Helix angle.
         2) Glass content range.
         3) Strand yield.
         4) Strand per inch in the winding band.
         5) Ply thickness.
         6) Amount of chop or unidirectional roving interspersed with winding, if any, and location within laminate.
      k. For other components:
         1) Construction type.
         2) Laminate thicknesses.
         3) Ply sequences.
         4) Glass content range.
      l. For secondary overlays (both interior and exterior):
         1) Laminate thicknesses.
         2) Ply sequences and widths.

m. Construction details: Construction details for assembly and other special configurations, including:
    1) Tank bottom/top attachments with knuckle configuration and overlays and thicknesses.
    2) Tank support and anchor lugs, including attachment details.
    3) Tank nozzles and installation, including cutout reinforcement, gusseting, and similar items.
    4) Tank lateral or other support fabrication details, including platform attachment clips and/or shoulders.
    5) Scrubber configuration and fabrication details of internal support system and other specialty items.
    6) Cover panel joints, anchorage detail, and details of doors and inspection ports and their attachment or incorporation within the cover.
n. Miscellaneous equipment required.
o. Test reports and certification of compliance with physical property requirements.
p. Color samples.
q. Manufacturer's installation instructions.
r. ASME RTP-1 certification.

B. Operation and Maintenance Data.

C. Warranty.

1.06 QUALITY ASSURANCE

A. Manufacturer qualifications: Fiberglass reinforced plastic manufacturer with experienced personnel, physical facilities, and management capacity sufficient to produce custom-made glass fiber and resin products of quality and size specified for minimum 5 years with satisfactory performance record.

B. Quality assurance plan: Fabricator shall be responsible for implementation of a comprehensive quality assurance plan. The quality assurance plan describes procedures with the following minimum requirements:
    1. Fabricator shall designate personnel to inspect equipment while in process and after completion to assure compliance to every aspect of the section and fabrication drawings.
        a. Inspection shall include, as a minimum, checks for visual defects, laminate thickness and sequence, glass content, Barcol hardness, dimensional tolerances, adherence to construction details, surface preparation, and environmental conditions.
        b. Fabricator's inspector shall complete a report of the findings including method of measurement for each separate assembly.
    2. Prior to use of resins in fabrication, fabricator shall extract samples of resins and retain them for use by the ENGINEER. Sample size shall be 100 cubic centimeters minimum:
        a. Take 1 sample for each manufacturer's batch number if resin is received in the form it will be used.
        b. If the fabricator alters the resin after receipt, such as through the addition of styrene, promoters, or other additives, take samples from each drum or portion thereof mixed with additives.

c. Fabricator shall provide documentation for each sample including resin type, manufacturer, batch and lot number, drum number, complete listing of additives with amounts added, and description and manufacturer of each additive.

3. Fabricator shall inspect glass reinforcement prior to use in fabrication.
   a. Do not use glass that does not meet the manufacturer's acceptance standards.
   b. Do not use glass material that is wet or has been wet.
   c. For each type of glass and lot number used, fabricator shall record the manufacturer, product description, binder type, product code, production date, and lot number.
   d. For mat, woven roving, unidirectional roving, and cloth, also include in records actual measured weight per square yard of material.
4. Fabricator shall retain nozzle cutouts and other excess laminate, clearly marking each piece to identify its original location. These laminate samples become the property of the OWNER.
5. For areas where valid laminate samples are not available, take sample plugs at the ENGINEER's request.
   a. Repair subsequent holes in a manner acceptable to the ENGINEER.
6. Fabricator shall verify glass content on available samples in accordance with ASTM D 2584. Complete this test and submit the results complete for each major component where samples are available.
7. Prior to final shipment of the equipment, fabricator shall submit to the ENGINEER a complete quality control report, consisting of copies of records maintained for compliance with this section.

PART 2 PRODUCTS

2.01 RESIN AND REINFORCEMENT MATERIALS

A. General physical properties: In accordance with applicable specifications PS15-69, ASTM C 582, ASTM D 3299, ASTM D 4097, and ASME RTP-1 with verification of properties. Physical properties may include tensile, flexural, and compression modulus of elasticity and ultimate strengths, limiting strains, Poisson ratios, coefficients of expansion, and other directional properties as required for the design of the equipment.

B. Resin:
   1. Fabricate equipment using the corrosion-resistant resin(s) specified in the fiberglass reinforced plastic equipment specifications. The fabricator is required to obtain independent endorsement of each resin selection from the resin manufacturer. Unless otherwise specified, use the resin throughout laminates.
   2. The type of catalyst recommended varies between resin manufacturers. Submit resin/catalyst before fabrication begins to verify compliance to the resin manufacturer's recommended procedures.
   3. Employ no fillers, additives, or pigments in the resin.
      a. A thixotropic agent for viscosity control may be used in the proportion and type recommended by the resin manufacturer.
      b. Use no thixotropic agent in the corrosion liner or on surfaces to be in contact with the corrosive environment.

4. Make resin putty using the same resin as was used in the original fabrication and shall contain milled glass fibers.
   a. The use of silica flour, grinding dust, or other fillers is not allowed.
5. When specified, add antimony trioxide or antimony pentoxide to the resin in the amount necessary to achieve the required fire retardancy rating in the structural wall only. Follow resin manufacturer's recommendations.
   a. Unless otherwise specified, the corrosion liner shall not contain this additive.

C. Reinforcement:
1. Show the type and sequence of reinforcements to be used on the fabrication drawings.
2. Use as commercial grade corrosion-resistant borosilicate glass fiber reinforcement, unless otherwise specified.
3. Use glass fiber reinforcing having a surface finish and binder that is specifically recommended by the glass manufacturer for the particular resin system to be used.
4. Use Type C (chemical grade) glass, 10 mils (0.01 inches) thickness, or polyester surfacing veil, such as Nexus surfacing veils.
5. Use Type E (electrical grade) glass, 1-1/2 ounces or 3/4-ounce per square foot, with nominal fiber length of 1.25, within 0.75 inches mat.
6. Continuous glass roving used in chopper guns for spray up shall be Type E chopper roving.
7. Woven roving shall be 24 ounces per square yard Type E glass and have a 5-by-4 plain weave.
8. Continuous roving used in filament wound structures shall be Type E glass winder roving with a yield of 200 yards or more per pound.
9. Use Type E glass unidirectional fabric. Weft unidirectional fabric shall be 15.7 ounces per square yard.
10. When specified, use Type ECR glass reinforcements supplied in similar fabric styles to those specified above.

2.02 FABRICATION

A. Molds:
1. Construct molds of a suitable material to produce a smooth and glossy corrosion liner surface on the fiberglass reinforced plastic equipment.
2. Covering of mandrels with cardboard must be accepted by the ENGINEER prior to start of fabrication.

B. Laminates:
1. Determine specified glass content in accordance with ASTM D 2584.
2. Consider laminate thicknesses shown on the fabrication drawings as construction minimums. Verify that minimum thicknesses are obtained using the laminate sequences specified. When only total laminate thicknesses are specified or indicated on the Drawings, the minimum allowable structural laminate thickness shall be the total laminate thickness less the specified corrosion liner thickness.
3. Interruptions in laminating sequence shall follow the application of a ply of mat and be succeeded by a ply of mat.
4. The interruption shall not exceed 24 hours, and the in-process surface must retain acetone sensitivity until laminating is resumed. Lack of compliance with

these aspects or indication that contamination of the surface has occurred shall require that surface preparation be accomplished before resuming.

5. Chopped strand glass applied by chopper gun is allowed in lieu of mat layers in the structural laminates only.
   a. Chopper gun application of the corrosion liner is not allowed.
6. Coat non-mold surfaces with resin containing wax additive in the amount necessary to allow full cure of the surface. In the case of exterior surfaces, this wax coat shall also contain an ultraviolet stabilizer in the type and amount recommended by the resin manufacturer.
7. The exterior surface of equipment shall be resin-rich and reinforced with 1 layer C glass surfacing veil, unless otherwise specified.
8. When specified, the exterior coat shall be an opaque pigmented surface coat, applied only after ENGINEER's inspection. Color shall be selected by the ENGINEER.

C. Corrosion liner laminates:
   1. The inner surface of laminates shall be resin-rich and reinforced with surfacing veil of the type and number of layers as shown on the fabrication drawings.
   2. The interior layer of the corrosion liner shall consist of 1-1/2 ounces per square foot mat in the number of layers specified on the fabrication drawings. An exotherm interruption is specifically prohibited within the corrosion liner.
   3. Chopped glass applied by chopper gun is not allowed in the corrosion liner.
   4. Plies of the inner surface and interior layer are to gel completely before proceeding with the structural laminates.
   5. Completed corrosion liner as described above shall contain not less than 20 percent nor more than 30 percent glass by weight.
      a. Use no thixotropic material in the resin for the liner, nor in the fabrication of fiberglass reinforced plastic components intended for internal service.
      b. The completed liner shall be the minimum thickness specified or indicated on the Drawings.
   6. Do not use a separately cured unreinforced gel coat.

D. Hand lay-up structural laminates:
   1. The corrosion liner laminate shall be followed by hand lay-up structural laminates of varying reinforcement sequences as indicated on the fabrication drawings.
   2. For hand lay-up structural laminates, reinforcement shall consist of mat and woven roving in the sequence specified on the fabrication drawings.
   3. Woven roving shall have a ply of mat on each side. Two adjacent plies of woven roving are not permitted.
   4. Laminates containing primarily 1-1/2 ounces per square foot mat layers in conjunction with woven roving shall contain not less than 35 percent or more than 45 percent glass (by weight).
   5. Laminates containing primarily 3/4-ounce per square foot mat layers in conjunction with woven roving are considered to be high strength laminates and shall contain not less than 45 percent or more than 55 percent glass by weight.

E. Filament wound structural laminates:
   1. The corrosion liner laminate shall be followed by filament wound structural laminates as indicated on the fabrication drawings.

2. For filament wound structural laminates, reinforcement shall consist of continuous strand fiberglass roving applied with a minimum of interruptions until the specified minimum thickness is attained.
    a. This laminate shall contain 55 to 70 percent glass by weight as indicated on the fabrication drawings.
3. Each complete cycle of filament winding shall form a closed pattern of winding bands which completely covers the surface with 2 bi-directional layers.
    a. Each layer shall be a maximum of 1 roving in thickness.
    b. Uniformly space the filaments across the winding band without bunching or gaping.
4. Specify the helix angle of winding on the approved fabrication drawings, as measured from the centerline of revolution of the equipment shell.
5. Tolerance on helix angle is plus or minus 2 degrees, unless otherwise specified.
6. The fabrication drawings may require that layers of unidirectional roving be interspersed within the continuous filament winding.
7. Apply the unidirectional roving with the glass strand aligned in the axial direction, to within plus or minus 5 degrees.
8. If layers of mat or chopped glass are needed to ensure proper bonding of unidirectional roving, or within the filament winding to accommodate the Fabricator's manufacturing methods, consider the layers' extra material that will result in a thickness greater than specified. The amount of filament winding and unidirectional roving specified must still be applied.

F. Joining laminates:
1. Fiberglass reinforced plastic joining laminates are subject to applicable requirements specified in other sections for laminates.
2. Reinforce fiberglass reinforced plastic joints with an overlay of glass reinforcement and resin which extends equally within plus or minus 1/2 inch on each side of the joint. Use minimum thickness, ply sequence, and ply widths of fiberglass reinforced plastic joints as indicated on fabrication drawings.
3. Restrain parts to be joined to prevent movement until completion and cure of the joint overlay.
4. Fit-up parts and verify that tolerances and assembly requirements are satisfied. Completely fill the void between component parts with resin putty, taking care not to extrude an excessive amount of putty into the interior.

G. Environment:
1. The fabrication process and materials at the point of fabrication are to be maintained within a range of 60 to 95 degrees Fahrenheit. This temperature must also be at least 5 degrees greater than wet bulb temperature, as measured with a sling psychrometer.
2. Store materials in a dry area and within the temperature and humidity limits recommended by the manufacturers.

H. Flanges:
1. Make flanges by hand lay-up construction with nozzle neck and flange made integrally in 1 piece and fabricated in accordance with the dimensions indicated on the fabrication drawings. Extend layers of reinforcement in the nozzle neck and hub uninterrupted into the flange.
2. Build-up additional hub thickness using alternating layers of 1-1/2 ounces per square foot mat and 24 ounces per square yard woven roving.

3. Build-up additional thickness in the flange using "ring" cutouts of mat, evenly distributed throughout the flange thickness.
4. Press molded or filament wound flanges are not allowed.
5. Overall machine facing of the back of flanges is not permitted.
   a. To obtain proper seating, spotface bolt holes for SAE size washers.
   b. Resin coat bolt holes and other cut surfaces so that no fibers are exposed.
   c. Spotfacing shall not produce a flange thickness less than indicated in the fabrication drawings.
6. Bolt holes in flanges shall straddle principal centerlines of the Equipment. Tolerance in bolt hole locations and in diameter of bolt circle shall be plus 1/16 inch.
7. Depressions or projections in flange face shall be no greater than 1/32 inch.

I. Allowable visual defects:
   1. Visual defects in areas of the equipment shall not exceed the maximum allowable levels of visual defects set forth in Table A, unless acceptable to ENGINEER.
   2. Visual defects in accordance with ASTM D 2563.
   3. Presence of visual defects in excess of the allowable levels of Table A shall be grounds for rejection of the equipment. Listed quantities apply to small, localized areas and shall not be averaged over larger areas.
   4. For the purpose of Table A, use of the following definitions apply:
      a. INNER surface - Interior process surface, thickness of surfacing veil(s), and interface between veils and mat layers. Includes surfacing veils on internal joints.
      b. Interior mat layers - Layers of mat following the inner surface, and interface between liner and structural wall. Includes mat layers on internal joints.
      c. Structural wall - Layers of filament winding or alternating layers of mat and woven roving following the corrosion liner, and layers of mat and woven roving in internal overlays.
      d. Exterior surface - The exterior surface of the laminate and the thickness of the surfacing veil.
      e. Dimensions listed in Table A refer to the largest dimension measured for defects.

TABLE A
MAXIMUM ALLOWABLE LEVELS OF VISUAL DEFECTS

Condition/ Defect	Inner Surface	Interior Mat Layers	Structural Wall	Exterior Surface
Chip	None	None	None	
Crack	None	None	None	
Crazing	None	None	None	
Delamination	None	None	See Air Bubble	
Dry Spot	None	See Air Bubble	See Air Bubble	
Foreign Inclusion	None	Maximum Diameter 1/32"	See Air Bubble	
Fracture	None	None	None	None

TABLE A MAXIMUM ALLOWABLE LEVELS OF VISUAL DEFECTS				
Condition/ Defect	**Inner Surface**	**Interior Mat Layers**	**Structural Wall**	**Exterior Surface**
Air Bubble/ Void	Less than 1/64" Ø unlimited. 1/64" to 1/16" Ø 2 / sq. in. Maximum Diameter 1/16"	Less than 1/32" Ø unlimited. 1/32" to 1/8" Ø 5 / sq. in. Maximum Diameter 1/8"	Less than 3/16" Ø unlimited. 3/16" to 1/4" Ø 2 / sq. in. Maximum Diameter 1/4"	
Blister	See Air Bubble	See Air Bubble	See Air Bubble	
Burned	None	None	None	
Pit (Pinhole)	Less than 1/32" Ø 50/square feet 1/32" to 1/16" Ø 10/square feet Maximum Diameter 1/16" Maximum Depth 1/32"	N/A	N/A	
Resin Pocket	None	Maximum 1 square inch per occurrence.	Maximum 1 square inch per occurrence.	
Wrinkle	Allowable if laminate is glass reinforced. No sharp edges allowed.	Allowable if laminate is glass reinforced and full mat layer thickness and total thick- ness are maintained.	Allowable if laminate is glass reinforced and full mat layer thickness and total thick- ness are maintained.	
Scratch	None	N/A	N/A	
Fiber Prominence	None	Maximum 10 fibers visible per square inch	Maximum 20 fibers visible per square inch	

2.03 SOURCE QUALITY CONTROL

A. Inspection:
   1. OWNER's inspection: Permit the ENGINEER access to the equipment during fabrication and upon completion for the purpose of verifying compliance to the Contract Documents. The inspection is not intended to replace the Fabricator's own quality control procedures.
   2. In no respect does inspection of equipment by ENGINEER relieve the Fabricator of compliance with the Contract Documents.
      a. A final inspection will be performed by the ENGINEER.
   3. The Fabricator shall notify the ENGINEER at the completion of particular milestones during fabrication. The milestones are as follows:
      a. View tooling prior to fabrication.
      b. Beginning application of corrosion liner for each part, extraction of each part prior to beginning assembly.
      c. Upon completion of each separate assembly, ENGINEER reserves the right to include additional milestones.

4. Allow ENGINEER to photograph the equipment while in process and/or upon completion.
5. ENGINEER may use magnification or other special viewing or measurement devices during inspection.
6. Evidence of poor workmanship or lack of compliance with aspects of the Contract Documents will be grounds for rejection of the equipment.
7. Subsequent repair of rejected equipment may, at the ENGINEER's option, be undertaken in an attempt to bring the equipment to an acceptable state.
   a. Repair procedures must be accepted by the ENGINEER prior to implementation.

2.04 TESTING

A. The ENGINEER may employ destructive testing, such as ultimate tensile or flexure strength tests or glass content ignition tests, on available samples or use other non-destructive test methods, such as acoustic emission or ultrasonic polygauge thickness measurement, on the completed equipment for verification of compliance to the contract documents.

B. Testing performed by the ENGINEER will be accomplished through use of applicable ASTM test methods when appropriate.

C. Hardness tests will be made for acceptance by the ENGINEER on the liner surface using the Barcol impressor, Model GYZJ 934 1, calibrated at 2 points in accordance with ASTM D 2583.
   1. Ten readings will be taken in a localized area, deleting the 2 highest and 2 lowest, and averaging the remaining 6.
   2. Minimum acceptable Barcol hardness will be a reading of 30 unless otherwise specified.

D. An acetone sensitivity test will also be performed by the ENGINEER as an acceptance criteria. Evidence of a sticky or tacky surface following rubbing with an acetone-saturated cloth will be grounds for rejection of the equipment.

PART 3 EXECUTION

Not Used.

END OF SECTION

SECTION 06611

FIBERGLASS REINFORCED PLASTIC FABRICATIONS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Fiberglass reinforced plastic fabrications including:
   1. Grating.
   2. FRP Structural Shapes.

B. Related sections:
   1. The Contract Documents are complementary; what is called for by one is as binding as if called for by all.
   2. It is the CONTRACTOR's responsibility for scheduling and coordinating the Work of subcontractors, suppliers, and other individuals or entities performing or furnishing any of CONTRACTOR's Work.
   3. The following sections are related to the Work described in this Section. This list of related sections is provided for convenience only and is not intended to excuse or otherwise diminish the duty of the CONTRACTOR to see that the completed Work complies accurately with the Contract Documents.
      a. Section 01600 - Product Requirements.

1.02 REFERENCES

A. American National Standards Institute/NSF International (ANSI/NSF):
   1. ANSI/NSF Standard 61 - Drinking Water Treatment Chemicals-Health Effects.

PART 2 PRODUCTS

2.01 Grating

A. Manufacturers: One of the following or equal:
   1. IKG Industries, Nashville, TN, Irving. 2-inch HI47
   2. Strongwell-Chatfield Division, Chatfield, MN, Duradek. HD5000 2-inch Bearing Bar.

B. Materials:
   1. Core: Unidirectionally aligned glass fibers.
   2. Mat: Submit standard corrosion liner.
   3. Veil: Submit standard corrosion liner.
   4. Ultraviolet Stabilizer: Added to the exterior surfaces in the type and amount recommended by the resin manufacturer.
   5. Resin: Fire retardant premium vinyl ester, antimony trioxide or pentoxide added to meet Class I flame spread rating of ASTM E 84 and self-extinguishing requirements of ASTM D 625, as manufactured by on of the following or equal as recommended by the resin manufacturer for the specific operating environment:
      a. Dow Derakane 530.

b. Ashland Hetron 992.
c. Interplastic VE 8400.
d. Reichhold Dion VER 9300FR.

6. Color: Grey or as indicated on the Drawings.
7. Anti-slip coating: Permanently bonded grit of selected color.

C. Design criteria and chemical exposure:
1. Weight: Approximately 10.9 pounds per square foot for 2 inch high grating with open area of minimum 47 percent.
2. Suitability: Use stairs and grating suitable for use in environments containing chlorine and sodium bisulfate solutions at the temperatures and concentrations specified for the application.

D. Components:
1. Bearing bars: I-bars, 2 inches deep, I-bars spaced at 1-3/16 inches on center.
2. Cross bars: Spaced at 6 inches on center.
3. Hold downs, connectors, and accessories: As recommended by grating manufacturer.

E. Fabrication:
1. Produce grating bearing and cross bars by pultrusion process. Do not use hand lay-up construction methods.
2. Coat ends of grating with resin.
3. Fabricate single sections for each span. Do not clamp 2 or more grating sections together within spans.
4. Type 316 stainless steel plates and angles at openings:
a. Install 5/8-inch thick plate or angle where required to fill openings at changes in elevation and at openings between equipment and grating.
b. Install angle stops at ends of grating to prevent grating from sliding.
5. Maximum 1/8-inch clearance allowed between ends of grating and inside face of vertical leg of support angles.

F. Cutouts:
1. Provide where required for equipment access or penetrations, including valve operators, stems, and gate frames.
2. Seal cut edges with resin.

2.02 FRP STRUCTURAL SHAPES

A. Manufacturers: One of the following or equal:
1. Fibergrate, Dynaform.
2. Strongwell – Bristol Division, Bristol, VA., EXTREN.

B. Materials:
1. Structural shapes and plate shall be made from vinyl ester resin with fire retardant additives to meet a flame spread rating of less than 25 per ASTM E-84 and meet the self-extinguishing requirements of ASTM D-635. All structural shapes shall contain a UV inhibitor.
2. Structural FRP members' composition shall consist of a glass fiber reinforced polyester or vinyl ester resin matrix, approximately 50 percent glass by weight. A synthetic surface veil shall be the outermost layer covering the exterior surfaces. Glass strand rovings shall be used internally for longitudinal strength.

Continuous strand glass mats or stitched reinforcements shall be used internally for transverse strength.

3. Pultruded structural shapes are to have the minimum longitudinal mechanical properties listed below:

Property	ASTM Method	Value	Units
Tensile Strength	D-638	30,000 (206)	psi (MPa)
Tensile Modulus	D-638	2.5×10^6 (17.2)	psi (GPa)
Flexural Strength	D-790	30,000 (206)	psi (MPa)
Flexural Modulus (min)	D-790	1.6×10^6 (12.4)	psi (GPa)
Flexural Modulus (Full Section)	N/A	2.8×10^6 (19.3)	psi (GPa)
Short Beam Shear (Transverse)	D-2344	4,500 (31)	psi (MPa)
Shear Modulus (Transverse)	N/A	4.5×10^5 (3.1)	psi (GPa)
Coefficient of Thermal Expansion	D-696	4.4×10^{-6} (8.0×10^{-6})	in/in/°F (cm/cm/°C)
Flame Spread	E-84	25 or less	N/A

4. Manufacturers: One of the following or equal as recommended by the resin manufacturer for the specific operating environment:
   a. Ashland Derakane 441.
   b. Ashland Hetron FR992.
   c. Interplastic VE 8100.

C. Chemical environment:
   1. Chemically resistant for use in environments containing sodium hypochlorite and sodium bisulfate solutions at the temperatures and concentrations specified for the application.
   2. Suitable for service between temperature ranges of minus 30 degrees Fahrenheit to plus 120 degrees Fahrenheit.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that conditions are satisfactory for installation of products as specified in Section 01610.

3.02 ERECTION AND INSTALLATION, GENERAL

A. Install products where indicated on the Drawings in accordance with manufacturer's printed instructions.

B. Attach grating to supporting members with stainless steel clips at corners of each section.

C. Allow 1/8- inch maximum clearance between ends of grating and inside face of vertical leg of shelf angles.

D. Install stainless steel plates or angles where necessary to fill openings at changes in elevation and at openings between equipment and grating.

E. Installed grating shall not slide out of rebate or off support.

F. Weld stops in place, unless otherwise specified or indicated on the Drawings.

G. Top surfaces of grating sections adjacent to each other shall lie in same plane.

3.03 FRP STRUCTURAL SHAPES

A. Measurements: Structural shapes supplied shall meet the minimum dimensional requirements as shown or specified. The CONTRACTOR shall provide and/or verify measurements in field for work fabricated to fit field conditions as required by manufacturer to complete the work. Determine correct size and locations of required holes or coping from field dimensions before structural shape fabrication.

B. Sealing: All shop fabricated cuts or drilling shall be coated with vinyl ester resin to provide maximum corrosion resistance. All field fabricated cuts or drilling shall be coated similarly by the contractor in accordance with the manufacturer's instructions.

C. Hardware: Type 316 stainless steel bolts shall be provided.

END OF SECTION

SECTION 07900

JOINT SEALANTS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Acrylic-Latex sealant.
   2. Precast concrete joint sealant.
   3. Silicone sealant.
   4. Synthetic rubber sealing compound.
   5. Synthetic sponge rubber filler.
   6. Related materials.

1.02 REFERENCES

A. American Association of State Highway and Transportation Officials (AASHTO):
   1. M 198 - Standard Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants.

B. ASTM International (ASTM):
   1. C 920 - Standard Specification for Elastomeric Joint Sealants.
   2. D 412 - Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers - Tension.
   3. D 624 - Standard Test Method for Tear Strength of Conventional Vulcanized Rubber and Thermoplastic Elastomer.

C. Federal Specification (FS):
   1. FS TT-S-00227e - Sealing Compound, Elastomeric Type, Multi-Component.

1.03 SUBMITTALS

A. Product data.

B. Samples, include color selections.

C. Manufacturer's Installation Instructions.

D. Warranty.

1.04 QUALITY ASSURANCE

A. Manufacturer qualifications: Manufacturer of proposed product for minimum 5 years with satisfactory performance record.

B. Installer qualifications: Manufacturer approved installer of products similar to specified products on minimum 5 projects of similar scope as Project with satisfactory performance record.

1.05 PROJECT/SITE CONDITIONS

A. Environmental requirements: Do not apply sealant on wet or frosty surfaces or when surface temperature is higher than 100 degrees Fahrenheit or lower than recommended by the manufacturer.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, and handle products in accordance with manufacturer's recommendations.

B. Code date packages. Do not use material older than manufacturer's published shelf life. Store materials at temperatures lower than 80 degrees Fahrenheit. Condition materials in accordance with manufacturer's instructions prior to installation.

1.07 SEQUENCING AND SCHEDULING

A. Caulk joints prior to painting.

1.08 WARRANTY

A. Warrant to correct defective products for minimum 5 years in accordance with manufacturer's standard warranty.

PART 2 PRODUCTS

2.01 ACRYLIC-LATEX SEALANT

A. Permanently flexible, nonstaining, and nonbleeding latex modified acrylic sealant compound, colors as selected by ENGINEER from manufacturer's standard options. Manufacturers: One of the following or equal:
   1. Tremco, Tremflex 834.
   2. Pecora Corp., Number AC-20.
   3. Sonneborn, Sonolac.

2.02 PRECAST CONCRETE JOINT SEALANT

A. Preformed, cold-applied, ready-to-use, flexible joint sealant in accordance with ASTM C990 and AASHTO M 198. Manufacturers: One of the following or equal.
   1. Henry Corporation, Ram-Nek.
   2. Concrete Sealants Division, ConSeal.

2.03 SILICONE SEALANT

A. ASTM C 920, Type S, Grade NS, Class 25, single component silicone sealant. Manufacturers: One of the following or equal:
   1. Tremco, Proglaze.
   2. Pecora Corp., Number 864.
   3. Dow Corning, Number 795.
   4. General Electric, Number 1200 Series.

2.04 SYNTHETIC RUBBER SEALING COMPOUND

A. Manufacturer: One of the following or equal:
   1. Sika Corporation, Lyndhurst, NJ, Sikaflex 2c NS or SL
   2. Polymeric Systems, Inc., PSI 275.
   3. Pacific Polymers, Garden Grove, CA, Elastothane 227R.

B. Material: In accordance with ASTM C 920 Type M, Grade P (pourable), Class 25 and Type M, Grade NS (non-sag), Class 25; multi-part polyurethane; able to cure at room temperature to firm, highly resilient rubber; able to perform satisfactory when continuously submerged in water or sewage and exposed to direct sunlight in dry condition; with the following properties determined at 75 degrees Fahrenheit and 50 percent relative humidity:
   1. Base: Polyurethane rubber.
   2. Solids: Minimum 97 percent.
   3. Application time: Minimum 2 hours.
   4. Cure time: Maximum 3 days.
   5. Tack free time: 24 hours.
   6. Ultimate hardness: Non-sag 25, Pourable/SL 40, within 5 Shore A.
   7. Tensile strength: Non-sag 120 pounds per square inch minimum and Self-leveling minimum 170 pounds per square inch when tested in accordance with ASTM D 412.
   8. Ultimate elongation: Minimum 490 percent when tested in accordance with ASTM D 412.
   9. Tear resistance: Non-sag 45 pounds per inch minimum and Self-leveling minimum 85 pounds per inch when tested in accordance with ASTM D 624, Die C.
   10. Service temperature range: Minus 25 degrees to 158 degrees Fahrenheit.

C. Color: Gray to match concrete, unless indicated on the Drawings.

2.05 SYNTHETIC SPONGE RUBBER FILLER

A. Closed-cell expanded sponge rubber manufactured from synthetic polymer neoprene base, or resilient polyethylene foam backer rod. Manufacturers: One of the following or equal:
   1. Presstite, Number 750.3 Ropax Rod Stock.
   2. Rubatex Corp., Rubatex-Cord.

B. Characteristics:
   1. Suitable for application intended.
   2. Strength: As necessary for supporting sealing compound during application.
   3. Resiliency: Sufficient resiliency to prevent significant load transfer across joint.
   4. Resistance to environmental conditions of installation.
   5. Bonding: No bonding to the sealing compound.
   6. Structure: Cellular, prevents wicking or absorption of water.
   7. Compatibility with other materials in joint and acceptance by manufacturer of sealing compound.
   8. Size: Minimum 25 percent greater than nominal joint width.

2.06 RELATED MATERIALS

A. Primer: Nonstaining type, recommended by sealant manufacturer to suit application.

B. Joint cleaner: Noncorrosive, nonstaining, compatible with joint forming materials and as recommended by sealant manufacturer.

C. Bond breaker tape: Pressure-sensitive tape recommended by sealant manufacturer to suit application.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify acceptability of joint dimensions, physical, and environmental conditions.

B. Verify that surfaces are dry, clean, and free of dirt, grease, curing compound, and other residue which might interfere with adhesion of sealants.

3.02 PREPARATION

A. Allow concrete to cure thoroughly before caulking.

B. Synthetic sponge rubber filler:
   1. Prepare surfaces designated to receive filler in accordance with manufacturer's installation instructions.
   2. Do not stretch filler beyond its normal length during installation.

C. Caulking:
   1. Verify that surfaces are dry, clean, and free of dirt, grease, curing compounds, and other residue that might interfere with adhesion of caulking compound.
   2. Concrete, masonry, wood, and steel surfaces: Clean and prime in accordance with manufacturer's instructions prior to caulking.

D. Synthetic rubber sealing compound:
   1. Ensure surfaces to which synthetic rubber must bond are dry and free of dust, dirt, and other foreign residue.
   2. Heavy sandblasted caulking groove to sound surface, and prime with manufacturer's recommended primer for particular surface.

E. For sidewalks, pavements, and similar joints sealed with elastomeric sealants and subject to traffic and other abrasion and indentation exposures, fill joints to depth equal to 75 percent of joint width, but neither more than 5/8 inches deep nor less then 3/8 inches deep.

F. For normal moving building joints sealed with elastomeric sealants not subject to traffic, fill joints to depth equal to 50 percent of joint width, but neither more than 1/2 inch deep nor less than 1/4 inch deep.

G. For joints sealed with acrylic-latex sealants, fill joints to depth in range of 75 percent to 125 percent of joint width.

H. Use joint filler to achieve required joint depths, to allow sealants to perform properly.

I. Prepare surfaces and install synthetic sponge rubber filler in accordance with manufacturer's recommendations.

J. Do not stretch filler beyond normal length during installation.

K. Apply bond breaker when recommended by joint sealer manufacturer.

3.03 INSTALLATION

A. Synthetic sponge rubber filler: Install filler in accordance with manufacturer's installation instructions.

B. Caulking, joints, and sealing:
   1. Construct expansion, contraction, and construction joints as indicated on the Drawings.
   2. Install pipe and conduit in structures as indicated on the Drawings.
   3. Caulk doors, windows, louvers, and other items installed in or over concrete openings inside and out.
   4. Use synthetic rubber sealing compound for caulking where indicated on the Drawings or as specified, except for masonry construction and where specified otherwise.
   5. Complete caulking prior to painting.
   6. Verify that concrete is thoroughly cured prior to caulking.
   7. When filler compressible material is used, use untreated type.
   8. Apply caulking with pneumatic caulking gun.
   9. Use nozzles of proper shape and size for application intended.
   10. Maintain continuous bond between caulking and sides of joint to eliminate gaps, bubbles, or voids and fill joint in continuous operation without layering of compound.
   11. Employ experienced applicators to caulk joints and seams in neat workmanlike manner.
   12. To hasten curing of compound when used on wide joints subject to movement, apply heat with infrared lamps or other convenient means.
   13. Apply synthetic rubber sealing compound with pneumatic caulking tool or other acceptable method.

3.04 CLEANING

A. Clean surfaces adjacent to sealant as work progresses.

B. Remove excess uncured sealant by soaking and scrubbing with sealant cleaning solvent.

C. Remove excess cured sealant by sanding with Number 80 grit sandpaper.

D. Leave finished work in neat, clean condition.

3.05 SCHEDULE

A. Synthetic rubber sealing compound, non-sag Type II:
   1. Use where indicated on the Drawings.
   2. Water-bearing and earth-bearing concrete structures.
   3. Joints in masonry, concrete vertical surfaces, and metal-faced panels in vertical surfaces.
   4. Joints between sheet metal flashing and trim.
   5. Joints between sheet metal flashing and trim, and vertical wall surfaces.

6. Small voids between materials requiring filling for weathertight performance in vertical surfaces.
7. Perimeters of frames of doors, windows, louvers, and other openings where bonding is critical to airtight performance.
8. Expansion and control joints in masonry vertical surfaces.

B. Synthetic rubber sealing compound, self-leveling Type I:
1. Use where indicated on the Drawings.
2. Expansion and control joints in masonry, concrete horizontal surfaces, and metal panels in horizontal surfaces.
3. Small voids between materials requiring filling for weathertight performance in horizontal surfaces.
4. Pavement joints.
5. Perimeters of frames of doors, windows, louvers, and other openings in horizontal surfaces where bonding is critical to airtight performance.

C. Silicone:
1. Use where indicated on the Drawings.
2. Joints and recesses formed where window, door, louver and vent frames, and sill adjoin masonry, concrete, stucco, or metal surfaces.
3. Door threshold bedding.
4. Moist or wet locations, including joints around plumbing fixtures.
5. Stainless steel doors and frames, including joints between applied stops and frames, and around anchor bolts.
6. Plenum joints.

D. Acrylic latex:
1. Use where indicated on the Drawings.
2. Interior joints with movement less than 7.5 percent and not subject to wet conditions.

END OF SECTION

SECTION 09885

NOVOLAC EPOXY LINING SYSTEM

PART 1 GENERAL

1.01 SCOPE

A. This Section covers furnishing and installation of a novolac epoxy corrosion protection system to be applied to the chemical containment sumps as indicated on the Drawings. This Section covers concrete surface preparation, furnishing, and application of the corrosion protection system suitable for the specified service conditions, the engineering field services to be provided by the material manufacturer that are required, and any appurtenances required to provide a complete corrosion protection system.

1.02 QUALITY ASSURANCE

A. Manufacturer's Field Services:
   1. The applicator of the protection system shall contact the protection system material manufacturer during the bidding phase of the project and shall include in the cost of this work the estimated cost of the manufacturer's engineering field services as specified.

B. The field services provided by the material manufacturer shall include review of the project before surface preparation; approving the applicator, the materials, and the procedure to be used; provide the adhesion testing, if testing for adhesion is required to determine compliance with the specified minimum pull-off adhesion strength; observation and approval of the surface preparation; and observing the application. The field representative of the protection system material manufacturer shall submit, through CONTRACTOR, written approvals of the proposed protection system materials, application procedures, applicator, and surface preparation. The field representative shall be an employee of the material manufacturer.

C. CONTRACTOR shall notify the material manufacturer and ENGINEER at least 10 days prior to anticipated date of placement of the protection system.

D. Applicator:
   1. The protection system applicator shall submit a satisfactory experience record including references for previous application of the specified protection system to concrete structures of similar design and complexity. The material manufacturer shall approve the applicator.

1.03 SUBMITTALS

A. Complete specifications and data on the protection system, application instructions, and material manufacturer's approvals of the protection system furnished under this Section shall be submitted in accordance with Section 01330. The protection system manufacturer shall provide certification for each component of the protection system that will provide corrosion resistance for the specified service conditions.

After application of the protection system, the material manufacturer shall certify that the protection system is free of pinholes and holidays.

1.04 DELIVERY, STORAGE, AND HANDLING

A. The material shall be delivered to the job site in original unopened containers with labels intact. Protection system components shall be stored indoors and shall be protected against freezing.

1.05 WARRANTY

A. Material manufacturer shall warrant the chemical resistance of the corrosion protection system for a period of 3 years from the date of substantial completion when exposed to the customer's normal operating conditions as stated in the specification. This warranty does not cover wear and tear such as abrasion resistance or mechanical abuse.

PART 2 PRODUCTS

2.01 PERFORMANCE AND DESIGN REQUIREMENTS

A. Conditions of Service: The protection system shall provide splash and spill protection for 72 hours from the following chemicals at a chemical temperature up to 150 degrees Fahrenheit (65 degrees Celsius):
   1. Sodium bisulfite at 38 percent concentration.

B. The lining will be exposed to sunlight and outdoor atmosphere.

2.02 MATERIALS

A. Materials shall be suitable for the specified service conditions. Products composing the corrosion protection system shall be chemically resistant to the chemicals, concentrations, temperatures, exposure times, and other relevant service conditions. In many cases, repair materials, primers, flexible basecoats, and other ancillary products that will be protected by a corrosion resistant and/or wear resistant layer of the protection system and may not be required to meet these criteria provided the overall protection system complies with the performance criteria. Each product of the protection system that complies with the performance requirements shall be certified as such by the protection system manufacturer. When recommended by the lining manufacturer, a vapor barrier shall be included as part of the corrosion protection system at no additional cost.

B. The corrosion protection system shall be a two-component, 100 percent solids, solvent-free, novolac vinyl ester resin, silica filled, high-build protective and waterproof coating, Dudick "Protecto-Flex 100XT." Concrete surface primer shall be an epoxy resin containing conductive fillers, 100 percent solids content, Dudick "Primer 67C." The flexible basecoat shall be certified by the material manufacturer as capable of not less than 50 mils of differential movement without damaging the corrosion protection system. The protection system shall include a chopped strand fiberglass mat reinforcement and saturant. Saturant for reinforcement shall be

epoxy resin. Finish coats shall be a two-component, 100 percent solids, novolac epoxy resin.

C. Chemical resistant caulking/sealant shall be suitable for the specified service conditions and shall be as recommended, in writing, by the protection system material manufacturer.

D. The specified corrosion protection system is manufactured by Dudick, Inc. Acceptable alternative manufacturers that may have a corrosion protection system that will satisfy the specified service conditions that may be furnished subject to review and acceptance by ENGINEER are General Polymers, KCC Corrosion Control Co. Ltd., Plasite, PolySpec Corporation, and Tnemec without exception. Other manufacturers and their corrosion protection systems will not be acceptable.

PART 3 EXECUTION

3.01 SURFACE PREPARATION

A. All surfaces shall be free of objectionable substances and shall meet the manufacturer's recommendations for surface preparation. If the lining material manufacturer recommends any other surface preparation, it shall be brought to ENGINEER's attention and may be incorporated into the work if acceptable to ENGINEER.

B. All surfaces shall be dry when coated and free from dirt, dust, sand, mud, oil, grease, rust, mill scale, and other objectionable substances. Oil and grease shall be completely removed as recommended by the material manufacturer before mechanical cleaning is started.

C. CONTRACTOR shall prepare the concrete surfaces in accordance with SSPC-SP 13/NACE 6. Concrete surfaces shall be prepared until they are acceptable to the lining material manufacturer.

D. Surface profile shall be 4 mils [100 µm] for a coating protection system and 22 mils [550 µm] for a lining protection system, but not less than 25 percent of the total dry film thickness specified for the corrosion protection system.

E. New concrete shall be cured for at least 4 weeks before the protection system is applied and shall be ready to receive the protection system as determined by the material manufacturer.

F. Concrete surfaces shall be tested for capillary moisture migration in the concrete in accordance with ASTM D4263. There shall be no capillary moisture after 24 hours as indicated by the test method. If the manufacturer recommends using the calcium chloride test method, ASTM F1869, to test for capillary moisture migration in the concrete and the test results exceed 3 pounds/24 hours/1,000 square feet or more stringent conditions recommended by the lining manufacturer, the corrosion protection system shall include a vapor barrier that is recommended by the corrosion protection material manufacturer.

G. Adhesion testing shall be conducted as specified herein after the concrete surface has been prepared and approved by the material manufacturer. Adhesion strength test results shall exceed 500 psi [3.4 MPa] or a higher value if recommended by material manufacturer.

H. All concrete surfaces to be lined shall be cleaned in accordance with ASTM D4258 and abrasive blasted in accordance with ASTM D4259. Before the protection system is applied, the surfaces shall be thoroughly washed, or cleaned by air blasting to remove all dust and residue. The CONTRACTOR shall repair all spalled areas, voids, and cracks and shall remove all fins and other surface projections to produce a flush surface for application of the protection system.

I. Concrete surfaces, including those with bug holes less than 1 inch [25 mm] in any dimension, shall be prepared using an epoxy concrete filler or as recommended by the corrosion protection system material manufacturer.

3.02 MIXING AND THINNING

A. Materials shall be thoroughly mixed each time any is withdrawn from the container and the containers shall be kept tightly closed except while material is being withdrawn.

B. Protection system components shall be mixed to proper consistency and viscosity in accordance with the manufacturer's recommendations. Thinning will not be permitted. No adulterant, unauthorized thinner, or other material not included in the formulation shall be added to the protection system components for any purpose.

3.03 APPLICATION

A. Corrosion protection system shall be applied in accordance with manufacturer's recommendations and in a neat manner, with finished surfaces free of runs, sags, ridges, laps, and brush marks. Corner protection and any other recommendations of the material manufacturer shall be provided. Grit shall be broadcast into first finish coat on the floor to produce an anti-skid surface.

B. The corrosion protection system shall be applied in four or more coats and shall consist of one prime coat, one basecoat with reinforcement and saturant, and two or more finish coats. The prime coat shall be at least 4 mils [150 µm] wet film thickness (WFT). The basecoat shall be trowel applied, to a thickness that provides the specified minimum differential movement. The reinforcement shall be pressed firmly into the basecoat, and then saturated with the basecoat resin mixture. Each finish coat shall be 15-20 mils [375-500 µm] dry film thickness (DFT). The protection system shall have a total dry film thickness of at least 100 mils [2,500 µm] DFT.

C. Each coat shall be applied over the previous coat in accordance with the recommendations of the material manufacturer. Each coat shall be applied in a manner that will produce an even film of uniform and proper thickness. In no case shall coating be applied at a rate of coverage that is greater than the maximum rate recommended by the material manufacturer.

D. Recoating shall be done in accordance with manufacturer's recommendations.

E. Alternate coats shall be of contrasting colors to facilitate in obtaining complete coverage. The first coat shall be of a dark color.

F. Protection system showing checks, blisters, excessive sags, teardrops, or fat edges will not be acceptable and shall be entirely removed and the surface recoated. The protection system shall be free of pinholes and holidays.

G. Protection system shall be applied when surface temperature is 50 degrees F or above and relative humidity is 90 percent or lower. Protection system shall not be applied in direct sunlight or when the temperature of the concrete is rising. Preferably the protection system shall be applied when the temperature of the concrete is dropping.

H. When applying high build coatings with a roller or brush and where a dry film thickness of at least 4 mils [100 µm] per coat is required, two or more coats shall be applied to achieve the recommended dry film thickness equal to a spray applied coating.

I. Corrosion resistant caulking/sealant shall be used at any penetration in the lining, such as at anchorage of pipe supports and chemical storage tanks.

3.04 FIELD QUALITY CONTROL

A. The surfaces shall be cleaned and prepared as needed to properly conduct the visual inspection, spark testing, and adhesion testing. All inspection and testing shall be witnessed by ENGINEER.

B. Visual Inspection: The surface of the protection system shall be visually inspected.

C. Spark Testing:
   1. After protection system is installed, the material manufacturer shall spark-test all concrete surfaces using an acceptable high-voltage electrical spark tester in accordance with ASTM D4787 and set at the recommended voltage, or as a minimum at 100 volts per mil [25 µm] of liner thickness. Before beginning the spark testing, the material manufacturer shall verify the testing equipment is working properly. The electrode movement shall be continuous and shall proceed in a systematic manner that will cover 100 percent of the lining surface. A carbon fiber brush shall be used on the sensor electrode.
   2. All detected holidays and pinholes shall be marked and repaired as recommended by the material manufacturer.

D. Adhesion Testing:
   1. Before the protection system is applied, an adhesion test shall be conducted on a properly prepared concrete surface that is acceptable to the material manufacturer and ENGINEER. The test area shall be at least 2 square feet [0.19 μm^2] to allow a minimum of three tests to be conducted. The test area shall be coated with the specified system and cured as recommended by the material manufacturer. Pull-off strength adhesion tests shall be conducted by the material manufacturer in accordance with ASTM D4541 using an Elcometer tensile adhesion tester. At least three adhesion tests shall be conducted and the results averaged. Adhesion strength shall equal or exceed

the minimum adhesion strength recommended by the material manufacturer and shall exceed the tensile strength of the concrete.

2. If the protection system fails the adhesion test, the cause of the failure shall be determined and corrected before the test is repeated.

3.05 PROTECTION

A. Care shall be taken to prevent protection system materials from being dropped or spilled on adjacent surfaces, buildings, structures, or facilities. All surfaces so damaged shall be cleaned, repaired, replaced, or coated as acceptable to the ENGINEER.

END OF SECTION

SECTION 09960

COATINGS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Field applied coatings.

B. Related sections:
   1. The Contract Documents are complementary; what is called for by one is as binding as if called for by all.
   2. It is the CONTRACTOR's responsibility for scheduling and coordinating the Work of subcontractors, suppliers, and other individuals or entities performing or furnishing any of CONTRACTOR's Work.
   3. The following sections are related to the Work described in this Section. This list of related sections is provided for convenience only and is not intended to excuse or otherwise diminish the duty of the CONTRACTOR to see that the completed Work complies accurately with the Contract Documents.
      a. Section 01140 - Work Restrictions.
      b. Section 01312 - Project Meetings.
      c. Section 01330 - Submittal Procedures.
      d. Section 01352 - Alteration Project Procedures.
      e. Section 01770 - Closeout Procedures.

1.02 REFERENCES

A. ASTM International (ASTM):
   1. D 4262 - Standard Test Method for pH of Chemically Cleaned or Etched Concrete Surfaces.
   2. D 4263 - Standard Test Method for Indicating Moisture in Concrete by the Plastic Sheet Method.
   3. D 4285 - Standard Test Method for Indicating Oil or Water in Compressed Air.
   4. D 4541 - Standard Test Method for Pull-off Strength of Coatings Using Portable Adhesion Testers.

B. NACE International, The Corrosion Society (NACE):
   1. SP0178 – Design, Fabrication, and Surface Finish Practices for Tanks and Vessels to Be Lined for Immersion Service.
   2. RPO188-99 - Discontinuity (Holiday) Testing of Protective Coatings.

C. National Association of Pipe Fabricators (NAPF):
   1. 500-03 - Surface Preparation Standard for Ductile Iron Pipe and Fittings Receiving Special External Coatings and/or Special Internal Linings.

D. NSF International (NSF):
   1. 61 - Drinking Water System Components - Health Effects.

E. SSPC - Society for Protective Coatings:
   1. SP COM – Surface Preparation Comentary for Steel and Concrete Substrates.
   2. SP1 - Solvent Cleaning.
   3. SP2 - Hand Tool Cleaning.
   4. SP3 - Power Tool Cleaning.
   5. SP5 - White Metal Blast Cleaning.
   6. SP6 - Commercial Blast Cleaning.
   7. SP7 - Brush-Off Blast Cleaning.
   8. SP10 - Near-White Blast Cleaning.
   9. SP11 - Power Tool Cleaning to Bare Metal.
   10. SP12 - Surface Preparation and Cleaning of Metals by Waterjetting Prior to Recoating.

F. U.S. Environmental Protection Agency (EPA):
   1. Method 24 – Surface Coatings.

G. Underwriters' Laboratory, Inc. (UL):
   1. 3P83 - Drinking Water System Components - Health Effects.

1.03 DEFINITIONS

A. Submerged metal: Steel or iron surfaces below tops of channel or structure walls which will contain water even when above expected water level.

B. Submerged concrete and masonry surfaces: Surfaces which are or will be:
   1. Underwater.
   2. In structures which normally contain water.
   3. Below tops of walls of water containing structures.

C. Exposed surface: Any metal or concrete surface, indoors or outdoors that is exposed to view.

D. Dry film thickness (DFT): Thickness of fully cured coating, measured in mils.

E. Volatile organic compound (VOC): Content of air polluting hydrocarbons in uncured coating product measured in units of grams per liter or pounds per gallon, as determined by EPA Method 24.

F. Ferrous: Cast iron, ductile iron, wrought iron, and all steel alloys except stainless steel.

G. Where SSPC surface preparation standards are specified or implied for ductile iron pipe or fittings, the equivalent NAPF surface preparation standard shall be substituted for the SSPC standard.

1.04 PERFORMANCE REQUIREMENTS

A. Coating materials for concrete and metal surfaces shall be especially adapted for use in water treatment plants.

B. Coating materials used in conjunction with potable water supply systems shall be certified to NSF 61 or UL 3P83.

1.05 SUBMITTALS

A. General: Submit in accordance with Section 01330.

B. Shop drawings: Include schedule of where and for what use coating materials are proposed in accordance with requirements for Product Data.

C. Product data: Include description of physical properties of coatings including solids content and ingredient analysis, VOC content, temperature resistance, typical exposures and limitations, and manufacturer's standard color chips:
   1. Regulatory requirements: Submit data concerning the following:
      a. Volatile organic compound limitations.
      b. Coatings containing lead compounds and PCBs.
      c. Abrasives and abrasive blast cleaning techniques, and disposal.
      d. NSF or UL certification of coatings for use in potable water supply systems.

D. Samples: Include 8-inch square drawdowns or brush-outs of topcoat finish when requested. Identify each sample as to finish, formula, color name and number and sheen name and gloss units.

E. Certificates: Submit in accordance with requirements for Product Data.

F. Manufacturer's instructions: Include the following:
   1. Special requirements for transportation and storage.
   2. Mixing instructions.
   3. Shelf life.
   4. Pot life of material.
   5. Precautions for applications free of defects.
   6. Surface preparation.
   7. Method of application.
   8. Recommended number of coats.
   9. Recommended dry film thickness (DFT) of each coat.
   10. Recommended total dry film thickness (DFT).
   11. Drying time of each coat, including prime coat.
   12. Required prime coat.
   13. Compatible and non-compatible prime coats.
   14. Recommended thinners, when recommended.
   15. Limits of ambient conditions during and after application.
   16. Time allowed between coats (minimum and maximum).
   17. Required protection from sun, wind and other conditions.
   18. Touch-up requirements and limitations.

G. Manufacturers representative's field reports.

H. Operations and maintenance data: Submit as specified in Section 01770.
   1. Reports on visits to project site to view and approve surface preparation of structures to be coated.
   2. Reports on visits to project site to observe and approve coating application procedures.
   3. Reports on visits to coating plants to observe and approve surface preparation and coating application on items that are "shop coated."

I. Quality assurance submittals:
   1. Quality assurance plan.
   2. Qualifications of coating applicator including list of similar projects.

1.06 QUALITY ASSURANCE

A. Applicator qualifications:
   1. Minimum of 5 years experience applying specified type or types of coatings under conditions similar to those of the Work:
      a. Provide qualifications of applicator and references listing 5 similar projects completed in the past 2 years.
   2. Manufacturer approved applicator when manufacturer has approved applicator program.

B. Regulatory requirements: Comply with governing agencies regulations by using coatings that do not exceed permissible volatile organic compound limits and do not contain lead:
   1. Do not use coal tar epoxy in contact with drinking water.

C. Certification: Certify that applicable pigments are resistant to discoloration or deterioration when exposed to hydrogen sulfide and other sewage gases and product data fails to designate coating as "fume resistant."

D. Field samples: Prepare and coat a minimum 100 square foot area between corners or limits such as control or construction joints of each system. Approved field sample may be part of Work.

E. Pre-installation conference: Conduct as specified in Section 01312.

F. Compatibility of coatings: Use products by same manufacturer for prime coats, intermediate coats, and finish coats on same surface, unless specified otherwise.

G. Services of coating manufacturers representative:
   1. Arrange for coating manufacturers representative to attend pre-installation conferences.
   2. Make periodic visits to the project site to provide consultation and inspection services during surface preparation and application of coatings, and to make visits to coating plants to observe and approve surface preparation procedures and coating application of items to be “shop primed and coated”.

1.07 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, and handle products in accordance with Section 01600.

B. Remove unspecified and unapproved paints from Project site immediately.

C. Deliver containers with labels identifying the manufacturer's name, brand name, product type, batch number, date of manufacturer, expiration date or shelf life, color, and mixing and reducing instructions.

D. Store coatings in well-ventilated facility that provides protection form the sun weather, and fire hazards. Maintain ambient storage temperature between 45 and 90 degrees Fahrenheit, unless otherwise recommended by the manufacturer.

E. Take precautions to prevent fire and spontaneous combustion.

1.08 PROJECT CONDITIONS

A. Surface moisture contents: Do not coat surfaces that exceed manufacturer specified moisture contents, or when not specified by the manufacturer, the following moisture contents:
   1. Concrete and concrete block: 12 percent.

B. Do not apply coatings:
   1. Under dusty conditions, unless tenting, covers, or other such protection is provided for structures to be coated.
   2. When light on surfaces measures less than 15 foot-candles.
   3. When ambient or surface temperature is less than 50 degrees Fahrenheit unless manufacturer allows a lower temperature.
   4. When relative humidity is higher than 85 percent.
   5. When surface temperature is less than 5 degrees Fahrenheit above dew point.
   6. When surface temperature exceeds the manufacturer's recommendation.
   7. When ambient temperature exceeds 90 degrees Fahrenheit, unless manufacturer allows a higher temperature.
   8. Apply clear finishes at minimum 65 degrees Fahrenheit.

C. Provide fans, heating devices, dehumidifiers, or other means recommended by coating manufacturer to prevent formation of condensate or dew on surface of substrate, coating between coats and within curing time following application of last coat.

D. Provide adequate continuous ventilation and sufficient heating facilities to maintain minimum 50 degrees Fahrenheit for 24 hours before, during and 48 hours after application of finishes.

1.09 SEQUENCING AND SCHEDULING

A. Sequence and schedule: As specified in Section 01140.

1.10 MAINTENANCE

A. Extra materials: Deliver in accordance with Section 01770. Include minimum 1 gallon of each type and color of coating applied:
   1. When manufacturer packages material in gallon cans, deliver unopened labeled cans as comes from factory.
   2. When manufacturer does not package material in gallon cans, deliver material in new gallon containers, properly sealed and identified with typed labels indicating brand, type and color.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Special coatings: One of the following or equal:
   1. Devoe: Devoe Coatings, Louisville, KY.
   2. Tnemec: Tnemec Co., Kansas City, MO.

2.02 PREPARATION AND PRETREATMENT MATERIALS

A. Metal pretreatment: As manufactured by one of the following or equal:
   1. Tnemec: Series N69 Hi-Build Epoxoline II.

B. Surface cleaner and degreaser: As manufactured by one of the following or equal:
   1. Devoe: Devprep 88.

2.03 COATING MATERIALS

A. Alkali resistant bitumastic: As manufactured by one of the following or equal:
   1. Tnemec: 46-465.

B. Wax coating: As manufactured by the following or equal:
   1. Sanchem: No-Ox-Id A special.

C. High solids epoxy primer not less than 80 percent solids by volume: As manufactured by one of the following or equal:
   1. Devoe: Bar Rust 233H.
   2. Tnemec:
      a. Series 135 Chembuild (non-immersion service).
      b. Series 104 HS (immersion service).

D. High solids epoxy not less than 80 percent solids by volume: As manufactured by one of the following or equal:
   1. Devoe: Bar Rust 233H.
   2. Tnemec:
      a. Series 135 Chembuild (non-immersion service).
      b. Series 104 HS (immersion service).

E. Aliphatic or aliphatic-acrylic polyurethane: As manufactured by one of the following or equal:
   1. Devoe: Devthane 379.
   2. Tnemec: Series 1075 (U) Endura-Shield II.

F. Asphalt varnish: AWWA C 500.

G. Coal tar epoxy substitute: As manufactured by one of the following or equal:
   1. Devoe: Devtar 5A.
   2. Waterborne acrylic emulsion: As manufactured by one of the following or equal:
      a. S-W: DTM Acrylic B66W1.
      b. Tnemec: Tneme-Cryl Series 6.

2.04 MIXES

A. Mix epoxy parts in accordance with manufacturer's instructions.

PART 3 EXECUTION

3.01 GENERAL PROTECTION

A. Protect adjacent surfaces from coatings and damage. Repair damage resulting from inadequate or unsuitable protection:

B. Protect adjacent surfaces not to be coated from spatter and droppings with drop cloths and other coverings:
   1. Mask off surfaces of items not to be coated or remove items from area.

C. Furnish sufficient drop cloths, shields and protective equipment to prevent spray or droppings from fouling surfaces not being coated and in particular, surfaces within storage and preparation area.

D. Place cotton waste, cloths and material which may constitute fire hazard in closed metal containers and remove daily from site.

E. Remove electrical plates, surface hardware, fittings and fastenings, prior to application of coating operations. Carefully store, clean and replace on completion of coating in each area. Do not use solvent or degreasers to clean hardware that may remove permanent lacquer finish.

3.02 GENERAL PREPARATION

A. Prepare surfaces in accordance with coating manufacturer's instructions, unless more stringent requirements are specified in this Specification.

B. Protect following surfaces from abrasive blasting by masking, or other means:
   1. Threaded portions of valve and gate stems.
   2. Machined surfaces for sliding contact.
   3. Surfaces to be assembled against gaskets.
   4. Surfaces of shafting on which sprockets are to fit.
   5. Surfaces of shafting on which bearings are to fit.
   6. Machined surfaces of bronze trim, including those slide gates.
   7. Cadmium-plated items except cadmium-plated, zinc-plated, or sherardized fasteners used in assembly of equipment requiring abrasive blasting.
   8. Galvanized items, unless scheduled to be coated.

C. Protect installed equipment, mechanical drives, and adjacent coated equipment from abrasive blasting to prevent damage caused by entering sand or dust.

D. Concrete:
   1. Allow new concrete to cure for minimum of 28 days before coating.
   2. Clean concrete surfaces of dust, mortar, fins, loose concrete particles, form release materials, oil, and grease. Fill voids so that surface is smooth. Etch or brush off-blast clean in accordance with SSPC SP-7 to provide surface profile similar to 60 grit sandpaper, or as recommended by coating manufacturer.

E. Ferrous metal surfaces:
   1. Remove grease and oil in accordance with SSPC SP-1.
   2. Remove rust, scale, and welding slag and spatter, and prepare surfaces in accordance with appropriate SSPC standard as specified herein.

3. Abrasive blast surfaces prior to coating.
4. When abrasive blasted surfaces rust or discolor before coating, abrasive blast surfaces again to remove rust and discoloration.
5. When metal surfaces are exposed because of coating damage, abrasive blast surfaces before touching-up.

F. Ferrous metal surfaces not to be submerged: Abrasive blast in accordance with SSPC SP-10, unless blasting may damage adjacent surfaces, prohibited or specified otherwise. Where not possible to abrasive blast, power tool clean surfaces in accordance with SSPC SP-3.

G. Ferrous metal surfaces to be submerged: Unless specified otherwise, abrasive blast in accordance with SSPC SP-5 to clean and provide roughened surface profile of not less than 2 mils and not more than 4 mils in depth when measured with Elcometer 123, or as recommended by the coating manufacturer.

H. Ductile iron pipe and fittings to be lined or coated: Abrasive blast clean in accordance with NAPF 500-03.

I. Sherardized, aluminum, copper, and bronze surfaces: Prepare in accordance with coating manufacturer's instructions.

J. Galvanized surface:
1. Degrease or solvent clean to remove oily residue.
2. Power tool or hand tool clean or whip abrasive blast.
3. Apply metal pretreatment within 24 hours before coating galvanized surfaces that cannot be thoroughly abraded physically, such as bolts, nuts, or preformed channels.

K. Shop primed metal:
1. Certify that primers applied to metal surfaces in the shop are compatible with coatings to be applied over such primers in the field.
2. Remove shop primer from metal to be submerged by abrasive blasting in accordance with SSPC SP-10, unless greater degree of surface preparation is required by coating manufacturer's representative.
3. Correct abraded, scratched or otherwise damaged areas of shop prime coat by sanding or abrasive blasting in accordance with SSPC SP-6.
4. When entire shop priming fails or has weathered excessively, or when recommended by coating manufacturer's representative, abrasive blast shop prime coat to remove entire coat and prepare surface in accordance with SSPC SP-10.
5. When incorrect prime coat is applied, remove incorrect prime coat by abrasive blasting in accordance with SSPC SP-10.
6. When prime coat not authorized by ENGINEER is applied, remove unauthorized prime coat by abrasive blasting in accordance with SSPC SP-10.
7. Shop Applied Bituminous Paint or Asphalt Varnish: Abrasive blast clean shop applied bituminous paint or asphalt varnish from surfaces scheduled to receive non-bituminous coatings.

L. Abrasive blast cadmium-plated, zinc-plated, or sherardized fasteners in same manner as unprotected metal when used in assembly of equipment designated for abrasive blasting.

M. Abrasive blast components to be attached to surfaces which cannot be abrasive blasted before components are attached.

N. Grind sharp edges to approximately 1/16 inch radius before abrasive blast cleaning.

O. Remove and grind smooth all excessive weld material and weld spatter before blast cleaning.

P. PVC and FRP surfaces:
   1. Prepare surfaces to be coated by light sanding and wipe-down with clean cloths, or by solvent cleaning in strict accordance with coating manufacturer's instructions.

Q. Cleaning of previously coated surfaces:
   1. Utilize cleaning agent to remove soluble salts such as chlorides and sulfates from concrete and metal surfaces:
      a. Cleaning agent: Biodegradable non-flammable and containing no volatile organic compounds.
      b. Manufacturer: Chlor-Rid International, Inc., or accepted equal.
   2. Cleaning of surfaces utilizing the decontamination cleaning agent may be accomplished in conjunction with abrasive blast cleaning, high pressure, washing, or hand washing as approved by the coating manufacturer's representative and the ENGINEER.
   3. Test cleaned surfaces in accordance with the cleaning agent manufacturer's instructions to ensure all soluble salts have been removed. Additional cleaning shall be carried out as necessary.
   4. Final surface preparation prior to application of new coating system shall be made in strict accordance with coating manufacturer's printed instructions.

3.03 MECHANICAL AND ELECTRICAL EQUIPMENT

A. Identify equipment, ducting, piping, and conduit in accordance with Section 15075 and Section 16075.

B. Remove grilles, covers and access panels for mechanical and electrical system from location and coat separately.

C. Finish coat primed equipment with color selected by the ENGINEER.

D. Prime and coat insulated and bare pipes, conduits, boxes, insulated and bare ducts, hangers, brackets, collars and supports, except where items are plated or covered with prefinished coating.

E. Replace identification markings on mechanical or electrical equipment when coated over or spattered.

F. Coat interior surfaces of air ducts, convector and baseboard heating cabinets that are visible through grilles and louvers with 1 coat of flat black paint, to limit of sight line.

G. Coat dampers exposed immediately behind louvers, grilles, convector and baseboard cabinets to match face panels.

H. Coat exposed conduit and electrical equipment occurring in finished areas with color and texture to match adjacent surfaces.

I. Coat both sides and edges of plywood backboards for electrical equipment before installing backboards and mounting equipment on them.

J. Color code equipment, piping, conduit and exposed ductwork and apply color banding and identification, such as flow arrows, naming and numbering, in accordance with Divisions 15 and 16.

3.04 GENERAL APPLICATION REQUIREMENTS

A. Apply coatings in accordance with manufacturer's instructions.

B. Coat metal unless specified otherwise:
   1. Aboveground piping to be coated shall be empty of contents during application of coatings.

C. Verify metal surface preparation immediately before applying coating in accordance with SSPC Pictorial Surface Preparation Standard.

D. Allow surfaces to dry, except where coating manufacturer requires surface wetting before coating.

E. Wash coat and prime sherardized, aluminum, copper, and bronze surfaces, or prime with manufacturer's recommended special primer.

F. Prime shop primed metal surfaces. Spot prime exposed metal of shop primed surfaces before applying primer over entire surface.

G. Apply minimum number of specified coats.

H. Apply coats to thicknesses specified, especially at edges and corners.

I. Apply additional coats when necessary to achieve specified thicknesses.

J. Coat surfaces without drops, ridges, waves, holidays, laps, or brush marks.

K. Remove spatter and droppings after completion of coating.

L. When multiple coats of same material are specified, tint prime coat and intermediate coats with suitable pigment to distinguish each coat.

M. Dust coatings between coats. Lightly sand and dust surfaces to receive high gloss finishes, unless instructed otherwise by coating manufacturer.

N. Apply coating by brush, roller, trowel, or spray, unless particular method of application is required by coating manufacturer's instructions or these Specifications.

O. Spray application:
   1. Stripe coat edges by brush before beginning spray application, as necessary, to ensure specified coating thickness along edges.

2. When using spray application, apply coating to thickness not greater than that recommended in coating manufacturer's instructions for brush coat application.
3. Use airless spray method, unless air spray method is required by coating manufacturer's instruction or these Specifications.
4. Conduct spray coating under controlled conditions. Protect adjacent construction and property from coating mist or spray.

P. Drying and recoating:
1. Provide fans, heating devices, or other means recommended by coating manufacturer to prevent formation of condensate or dew on surface of substrate, coating between coats and within curing time following application of last coat.
2. Limit drying time to that required by these Specifications or coating manufacturer's instructions.
3. Do not allow excessive drying time or exposure which may impair bond between coats.
4. Recoat epoxies within time limits recommended by coating manufacturer.
5. When time limits are exceeded, abrasive blast clean prior to applying another coat.
6. When limitation on time between abrasive blasting and coating cannot be met before attachment of components to surfaces which cannot be abrasive blasted, coat components before attachment.
7. Ensure primer and intermediate coats of coating are unscarred and completely integral at time of application of each succeeding coat.
8. Touch up suction spots between coats and apply additional coats where required to produce finished surface of solid, even color, free of defects.
9. Leave no holidays.
10. Sand and recoat scratched, contaminated, or otherwise damaged coating surfaces so damages are invisible to naked eye.

Q. Concrete:
1. Apply first coat (primer) only when surface temperature of concrete is decreasing in order to eliminate effects of off-gassing on coating.

3.05 ALKALI RESISTANT BITUMASTIC

A. Preparation:
1. Prepare surfaces in accordance with general preparation requirements.

B. Application:
1. Apply in accordance with general application requirements and as follows:
a. Apply at least 2 coats, 8 to 14 mils dry film thickness each.

3.06 WAX COATING

A. Preparation:
1. Prepare surfaces in accordance with general preparation requirements.

B. Application:
1. Apply in accordance with general application requirements and as follows:
a. Apply at least 1/32-inch thick coat with 2-inch or shorter bristle brush.
b. Thoroughly rub coating into metal surface with canvas covered wood block or canvas glove.

3.07 HIGH SOLIDS EPOXY SYSTEM

A. Preparation:
   1. Prepare surfaces in accordance with general preparation requirements and as follows:
      a. Abrasive blast ferrous metal surfaces to be submerged at jobsite in accordance with SSPC SP-5 prior to coating. When cleaned surfaces rust or discolor, abrasive blast surfaces in accordance with SSPC SP-10.
      b. Abrasive blast non-submerged ferrous metal surfaces at jobsite in accordance with SSPC SP-10, prior to coating. When cleaned surfaces rust or discolor, abrasive blast surfaces in accordance with SSPC SP-6.
      c. Abrasive blast clean ductile iron surfaces in accordance with SSPC SP-7.

B. Application:
   1. Apply coatings in accordance with general application requirements and as follows:
      a. Apply minimum 2-coat system with minimum total dry film thickness (DFT) of 12 mils.
      b. Recoat or apply succeeding epoxy coats within time limits recommended by manufacturer. Prepare surfaces for recoating in accordance with manufacturer's instructions.
      c. Coat metal to be submerged before installation when necessary, to obtain acceptable finish and to prevent damage to other surfaces.
      d. Coat entire surface of support brackets, stem guides, pipe clips, fasteners, and other metal devices bolted to concrete.
      e. Coat surface of items to be exposed and adjacent 1 inch to be concealed when embedded in concrete or masonry.

3.08 HIGH SOLIDS EPOXY AND POLYURETHANE COATING SYSTEM

A. Preparation:
   1. Prepare surfaces in accordance with general preparation requirements and as follows:
      a. Prepare concrete surfaces in accordance with general preparation requirements.
      b. Touch up shop primed steel and miscellaneous iron.
      c. Abrasive blast ferrous metal surfaces at jobsite in accordance with SSPC SP-6, Commercial Blast Cleaning, prior to coating. When cleaned surfaces rust or discolor, abrasive blast surfaces in accordance with SSPC SP-6.
      d. Degrease or solvent clean, whip abrasive blast, power tool, or hand tool clean galvanized metal surfaces.
      e. Lightly sand fiberglass and poly vinyl chloride (PVC) pipe to be coated and wipe clean with dry cloths, or solvent clean in accordance with coating manufacturer's instructions.
      f. Abrasive blast clean ductile iron surfaces.

B. Application:
   1. Apply coatings in accordance with general application requirements and as follows:
      a. Apply 3 coat system consisting of:
         1) Primer: 4 to 5 mils dry film thickness high solids epoxy primer.

2) Intermediate coat: 4 to 5 mils dry film thickness high solids epoxy intermediate coat.
3) Top coat: 2.5 to 3.5 mils dry film thickness aliphatic or aliphatic-acrylic polyurethane topcoat.

2. Recoat or apply succeeding epoxy coats within 30 days or within time limits recommended by manufacturer, whichever is shorter. Prepare surfaces for recoating in accordance with manufacturer's instructions.
3. For fiberglass and PVC pipe, apply 1 coat high solids epoxy (4 to 5 mils DFT) and 2 coats aliphatic or aliphatic-acrylic polyurethane.

3.09 ASPHALT VARNISH

A. Preparation:
1. Prepare surfaces in accordance with general preparation requirements.

B. Application:
1. Apply coatings in accordance with general application requirements and as follows:
a. Apply minimum 2 coats.

3.10 COAL TAR EPOXY SUBSTITUTE

A. Preparation:
1. Prepare surfaces in accordance with general preparation requirements and in accordance with the coating manufacturer's printed instructions.

B. Application:
1. Apply 2 coats at 6 mils to 8 mils each, for a minimum total DFT of 12 mils.

3.11 WATERBORNE ACRYLIC EMULSION

A. Preparation:
1. Remove all oil, grease, dirt, and other foreign material by Solvent Cleaning in accordance with SSPC SP-1.
2. Lightly sand all surfaces and wipe thoroughly with clean cotton cloths before applying coating.

B. Application:
1. Apply 2 or more coats to obtain a minimum dry film thickness (DFT) of 5.0 mils.

3.12 FIELD QUALITY CONTROL

A. Each coat will be inspected. Strip and remove defective coats, prepare surfaces and recoat. When approved, apply next coat.

B. Control and check dry film thicknesses and integrity of coatings.

C. Measure dry film thickness with calibrated thickness gauge.

D. Dry film thicknesses on ferrous-based substrates may be checked with Elcometer Type 1 Magnetic Pull-Off Gage or Positector 6000.

E. Verify coat integrity with low-voltage holiday detector. Allow ENGINEER to use detector for additional checking.

F. Check wet film thickness before coal tar epoxy coating cures on concrete or non-ferrous metal substrates.

G. Arrange for services of coating manufacturer's field representative to provide periodic field consultation and inspection services to ensure proper surface preparation of facilities and items to be coated, and to ensure proper application and curing:
   1. Notify ENGINEER 24 hours in advance of each visit by coating manufacturer's representative.
   2. Provide ENGINEER with a written report by coating manufacturer's representative within 48 hours following each visit.

H. In addition to testing by the CONTRACTOR, OWNER may also provide inspection services of a 3rd party coating inspector. OWNER or OWNER'S representative will field inspect and approve coatings.

3.13 SCHEDULE OF ITEMS NOT REQUIRING COATING

A. General: Unless specified otherwise, the following items do not require coating:
   1. Items that have received final coat at factory and not listed to receive coating in field.
   2. Aluminum, brass, bronze, copper, plastic (except PVC pipe), rubber, stainless steel, chrome, Everdur, or lead.
   3. Buried or encased piping or conduit.
   4. Exterior concrete.
   5. Galvanized roof decking that is covered by roofing materials, electrical conduits, pipe trays, cable trays, and other items:
      a. Areas on galvanized items or parts where galvanizing has been damaged during handling or construction shall be repaired as follows:
         1) Clean damaged areas by SSPC SP-1, SP-2, SP-3, or SP-7 as required.
         2) Apply 2 coats of a cold galvanizing zinc compound such as ZRC World Wide Inovatie Zinc Technologies of Marshfield, MA or accepted equal, in strict accordance with manufacturer's instructions.
   6. Grease fittings.
   7. Fiberglass ducting or tanks in concealed locations.
   8. Steel to be encased in concrete or masonry.

3.14 SCHEDULE OF SURFACES TO BE COATED IN THE FIELD

A. In general, apply coatings to steel, iron, galvanized surfaces, and wood surfaces unless specified or otherwise indicated on the Drawings. Coat concrete surfaces and anodized aluminum only when specified or indicated on the Drawings. Color coat all piping per Section 15075.

B. Following schedule is incomplete. Coat unlisted surfaces with same coating system as similar listed surfaces. Verify questionable surfaces.

C. Concrete:
   1. High solids epoxy:
      a. Safety markings.
   2. Coal tar epoxy substitute:

D. Metals:
   1. Alkali resistant bitumastic:
      a. Aluminum surfaces to be placed in contact with wood, concrete, or masonry.
   2. Wax coating:
      a. Sliding faces of sluice and slide gates and threaded portions of gate stems.
   3. High solids epoxy and polyurethane system: Interior and exterior non-immersed ferrous metal surfaces including:
      a. Doors, doorframes, ventilators, louvers, grilles, exposed sheet metal, and flashing.
      b. Pipe, valves, pipe hangers, supports and saddles, conduit, cable tray hangers, and supports.
      c. Motors and motor accessory equipment.
      d. Drive gear, drive housing, coupling housings, and miscellaneous gear drive equipment.
      e. Valve and gate operators and stands.
      f. Structural steel, including columns, girders, beams, plates, rolling gates, and top and bottom exposed surfaces for metal roof deck.
      g. Crane and hoist rails.
      h. Mechanical equipment supports, drive units, and accessories.
      i. Pumps not submerged.
      j. Degritters, grit classifiers, frames, supports, and associated equipment.
      k. Other miscellaneous metals.
      l. Grit separation and washer, frames, supports, and associated equipment.
   4. High solids epoxy system:
      a. Field priming of ferrous metal surfaces with defective shop prime coat where no other prime coat is specified; for non-immersion service.
      b. Bell rings, underside of manhole covers and frames.
      c. Sump pumps and grit pumps, including underside of base plates and submerged suction and discharge piping.
      d. Chlorine diffuser supports.
      e. Exterior of submerged piping and valves other than stainless steel or PVC piping.
      f. Submerged pipe supports and hangers.
      g. Stem guides.
      h. Vertical shaft mixers and aerators below supports.
      i. Other submerged iron and steel metal unless specified otherwise.
      j. Interior surface of suction inlet and volute of submersible influent pumps. Apply coating prior to pump testing.
      k. Submerged piping.
      l. Exterior of influent pumps and influent pump submerged discharge piping.
   5. Asphalt varnish:
      a. Underground valves and valve boxes.

E. Fiberglass and PVC pipe surfaces:
   1. Waterborne acrylic emulsion.
      a. Exterior of fiberglass ducting and fan housings.
      b. Fiberglass exposed to sunlight.
      c. PVC piping exposed to view.
      d. ABS piping as determined by ENGINEER.

END OF SECTION

SECTION 10400

IDENTIFICATION DEVICES

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes: Plastic and metal signs for building and site use.

B. Related Sections:
   1. Section 16075 - Electrical Identification

1.02 SUBMITTALS

A. Product Data.

B. Shop Drawings: Include lists of sign types, sizes, text, and colors; mounting details; locations; and cast metal plaque rubbings and templates.

C. Samples: Include actual materials.

D. Manufacturer's Installation Instructions.

1.03 QUALITY ASSURANCE

A. Manufacturer Qualifications: Manufacturer of proposed products for minimum five years with satisfactory performance record of minimum five years.

B. Installer Qualifications: Manufacturer-approved installer of products similar to specified products on minimum 10 projects of similar scope as Project with satisfactory performance record.

C. Regulatory Requirements: Provide signage in accordance with Americans with Disabilities Act.

PART 2 PRODUCTS

2.01 METAL SAFETY SIGNS

A. Manufacturer: Meeting OSHA Requirements; 40 mil thick aluminum with baked enamel finish. The following or equal:
   1. Seton Name Plate Co., New Haven, CT, Style SW-G, Special Wording.

B. Danger Sign Colors:
   1. Background: White.
   2. Heading: White lettering on red oval with white border in black rectangular panel.
   3. Message: Black lettering on white.

4. Size: As scheduled.

C. Caution Sign Colors:
   1. Background: Yellow.
   2. Heading: Yellow lettering on black rectangular panel.
   3. Message: Black lettering on yellow.
   4. Size: As scheduled.

D. Safety Instruction Signs:
   1. Background: White.
   2. Heading: White lettering on green rectangular panel.
   3. Message: Black lettering.
   4. Size: As scheduled.

E. Warning Signs:
   1. Background: Orange.
   2. Heading: Black lettering on orange diamond in black rectangular panel.
   3. Message: Flack lettering on orange.
   4. Size: As scheduled.

F. Notice Information Signs:
   1. Background: White.
   2. Heading: White lettering on blue rectangular panel.
   3. Message: Black lettering.
   4. Size: As scheduled.

G. Location, Text, Quantity: As scheduled in Schedule A.

H. Fasteners: Round head stainless steel bolts or screws.

2.02 NON-ELECTRICAL NAMEPLATES

A. Material and Fabrication: Stainless steel sheet, engraved or stamped with text, holes drilled or punched for fasteners.

B. Fasteners: Number 4 or larger oval head stainless steel screws or drive pins.

C. Text: Manufacturer's name, equipment model number and serial number, identification tag number, and when appropriate, drive speed, motor horsepower and rated capacity, pump rated total dynamic head, and impeller size.

2.03 ELECTRICAL NAMEPLATES

A. Material and Fabrication: Black lamicoid with white letters, holes drilled for fasteners.

B. Fasteners: Number 4 or larger oval head stainless steel screws or drive pins.

C. Text: Purpose and identification of load power source and circuit number for each disconnect means of service, feeder, branch, or equipment conductors and pushbutton station.

2.04 IDENTIFICATION DEVICES (including Hazard Materials Signs)

A. Manufacturer: The following or equal:
   1. Seton Name Plate Co., New Haven, CT.

B. Underground Warning Tapes: Metallic detection tape; minimum 4 mil thick by 6-inch wide polyethylene film with wording, caution, and name of service followed by words, line buried below, repeated continuously along tape length, and alternate metallic and color strips; blue for water, orange for telephone, red for electric, green for sewer, yellow for gas and other services.

C. Voltage Appliques: Seton-Code, vinyl with pressure-sensitive adhesive, orange color, 9 by 2-1/4 inches, approximately 1-1/4-inch high letters indicating voltage and word, volts.

D. Hazard Material Signs: In accordance with NFPA Coding System and NFC Standard 79-3; vinyl panels, letters, and symbols with pressure sensitive adhesive, sizes as required for viewing distances, letters and symbols in accordance with Schedule C.

PART 3 EXECUTION

3.01 PREPARATION

A. Protect adjacent surfaces which may be damaged by installation of signs.

B. Prepare substrates in accordance with sign manufacturer's instructions.

C. Remove scale, dirt, grease, and other contaminates from substrates.

3.02 INSTALLATION

A. Install signs in accordance with sign manufacturer's instructions.

B. Fasten signs securely in level, plumb, and true to plane positions.

C. Install metal traffic signs where indicated on the Drawings.

D. Lay underground warning tape approximately 6 inches below finish grade above service lines.

E. Apply voltage appliques on exposed medium voltage circuit raceways at maximum 50 feet on center.

3.03 SCHEDULES

A. Metal Safety and Informational Sign, Schedule A.

B. Identification Device, Schedule B.

END OF SECTION

SCHEDULE A

METAL SAFETY AND INFORMATIONAL SIGN SCHEDULE

A. EMERGENCY SHUT-OFF VALVE SIGNS:
   1. Location: Directly above the chemical storage tank suction isolation valves.
   2. Height: 24 inches above storage tank base.
   3. Size: 12-inch square.
   4. Heading: None.
   5. Wording: EMERGENCY SHUT-OFF VALVE

END OF SCHEDULE A
METAL SAFETY AND INFORMATIONAL SIGN SCHEDULE

SCHEDULE B

IDENTIFICATION DEVICE SCHEDULE

A. HAZARD SIGNAL FOR SODIUM BISULFITE (SBS):

1.	Location:	At entrances to locations where sodium bisulfite is stored and on storage tank(s).
2.	Height:	60 inches above floor to center of sign.
3.	View Distance:	50 feet.
4.	Health:	2.
5.	Flammability:	0.
6.	Reactivity:	1.
7.	Special:	--.

END OF SCHEDULE B
IDENTIFICATION DEVICE SCHEDULE

END OF SECTION

SECTION 11242

CHEMICAL FEED PUMPS

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes: Mechanical diaphragm metering pumps for pumping chemical solutions, calibrations columns, pressure relief protection, pulsation dampeners, backpressure valves, degassing valves, pressure switches, gauges, and control panel requirements.

B. Tag Numbers:
   1. See Section 2.02.

1.02 REFERENCES

A. American Bearing Manufacturer's Association (ABMA):
   1. 9 – Load Ratings and Fatigue Life for Ball Bearings.
   2. 11 – Load Ratings and Fatigue Life for Roller Bearings.

B. ASTM International (ASTM):
   1. D2240 – Test Method for Rubber Property – Durometer Hardness.
   2. D883 – Definition of Terms Relating to Plastics.
   3. D2583 – Test Method for Indentation Hardness of Rigid Plastics by Means of a Barcol Impressor.
   4. D2563 – Recommended Practice for Classifying Visual Defects in Glass Reinforced Plastic Laminate Parts.

1.03 SUBMITTALS

A. All submittals shall be in compliance with Section 01330:
   1. Strike any data for materials and components not provided as part of the Work.
   2. Provide a list of all parameters, ratings, or other characteristics where the proposed chemical feed systems deviate from the requirements set forth in these Specifications.

B. Shop Drawings:
   1. Manufacturer's literature, illustrations, specifications, and bill of materials for each component of the system. Data shall include a complete description in sufficient detail to permit comparison with these Specifications.
   2. Dimensions, including anchor bolt layout, materials of construction, size, weight, and performance data.
   3. Drawings: Provide electrical and instrumentation drawings showing coordination with all electrical control devices operating in conjunction with the associated feed system.
   4. Dimensioned inlet and outlet connections.

5. Current NSF 61 Certification for all components to be in contact with chemical solution or potable water.
6. Provide data showing chemical compatibility and history of service with the associated chemical for all materials in the system.

C. Chemical Feed Pumps:
1. For each pump type, furnish data including head and capacity.
2. Calibration curves.
3. Electrical and control drawings.

D. Control Panel Shop Drawings:
1. Control panel views showing equipment arrangement, doors, equipment layout inside the panel and dimensional information.
2. Internal interconnecting wiring diagrams showing terminal strips and all external devices connected to the panel, design submittal for loop and schematic diagrams.
3. ISA standard Loop Drawings for analog and discrete signals.
4. Complete schematic and diagrams including terminal block and wire identification numbers and device location symbols consistent with the Contract Documents.
5. Panel bill of material with detailed description of components and equipment data sheets.
6. Field cable numbers and terminations.

E. Manufacturer's installation instructions for all components.

F. Operation and Maintenance Data:
1. Submit copies of complete Operation and Maintenance Manuals, including any instrumentation.
2. Provide all safety considerations relating to operations and the handling of the associated chemical.
3. Complete, detailed operating instructions for each piece of equipment.
4. Recommended spare parts lists for all components.
5. Maintenance data shall include all information and instructions required by plant personnel to keep equipment properly cleaned, lubricated and adjusted so that it functions economically throughout its full design life.
   a. Explanation with illustrations as necessary for each maintenance task.
   b. Recommended schedule of maintenance tasks.
   c. Lubrication charts and tables of alternate lubricants.
   d. Troubleshooting instructions.
   e. List of maintenance tools and equipment.
   f. Name, address and phone number of manufacturer and manufacturer's local service representative.
6. Copy of warranty for each component.
7. Copy of the maintenance agreement specified herein.

1.04 PRODUCT DELIVERY, STORAGE AND HANDLING

A. All equipment and materials shall be inspected against approved Shop Drawings at time of delivery. Equipment and materials damaged or not meeting requirements of

the approved Shop Drawings shall be immediately returned to the system manufacturer for replacement or repair.

B. Equipment and materials shall be stored in a dry location and protected from the elements according to the system manufacturer's instruction.

1.05 SPARE PARTS

A. Tools, Spare Parts and Maintenance Materials: Furnish, the following spare parts:
   1. One complete liquid end with check valves for each size feed pump provided.
   2. One complete spare parts kit for each feed pump provided.
   3. One spare parts kit for each size of backpressure and pressure relief valve.

B. Spare parts shall be packed in sturdy containers with clear indelible identification markings and shall be stored in a dry, warm location until transferred to the OWNER at the completion of the Contract.

C. Furnish an initial supply of all oils, greases and lubricants required to start operations. Supply an amount of these materials equivalent to one year of continuous operation for each system.

1.06 WARRANTY

A. System shall be covered by a 1-year warranty against defects in materials and workmanship. Warranty period shall commence after on-site acceptance of equipment by OWNER. In addition, system shall be subject to the following provisions:
   1. If OWNER is dissatisfied with system performance within 30 days of start-up by manufacturer's authorized representative, system may be returned for full refund, provided system has received reasonable use and care.
   2. If OWNER and manufacturer's authorized representative determine, at time of start-up, that the system is improperly sized for the application, or if another system by the same manufacturer would be more suitable for any reason, the system will be exchanged at no penalty. OWNER will be charged or credited only the difference between the original and replacement systems, plus costs of shipping and handling. OWNER will not be billed for restocking the original system, nor for the second visit by the representative to start up the replacement.

PART 2 PRODUCTS

2.01 MATERIALS

A. All materials of construction must be suitable for constant contact with the chemical solution to be pumped and take into account current potable water practices.

B. Brass or bronze components are not acceptable for contact with sodium hypochlorite.

2.02 CHEMICAL FEED SYSTEMS EQUIPMENT

A. Provide feed equipment for chemical solutions as listed below. The OWNER shall purchase and supply the associated chemicals.

B. Feed Pumps:
   1. Characteristics: Chemical proportioning pumps of the positive displacement, non-loss of motion, mechanical diaphragm type.
   2. Repeatability: Plus or minus 2 percent of full scale at constant hydraulic conditions.
   3. Materials: The metering pumps and their components shall be suitable for the following chemical concentrations:
      a. Sodium Hypochlorite:
         1) All wetted parts shall be suitable for use with 8 to 12.5 percent sodium hypochlorite solution.
         2) All other non-specified materials are to be manufacturer's standard for continuous service with a 8 to 12.5 percent sodium hypochlorite solution.
      b. Sodium Bisulfite:
         1) All wetted parts shall be suitable for use with 40 percent Sodium Bisulfite solution.
         2) All other non-specified materials are to be manufacturer's standard for continuous service with a 40 percent sodium Bisulfite solution.
   4. Manufacturers:
      a. Wallace and Tiernan, Encore 700 pumps.
      b. Pulsafeeder, similar model.

Tag Numbers	Service	Quan. (each)	Max. Strokes/ min	Capacity (min/max gph)	Max. Press. (psig)	Power Supply	Input Signal	Min. Motor Size (hp)
65-DCLO-PMP-101 65-DCLO-PMP-102	40% Sodium Bisulfite	2	60	1.25/25	175	90 VDC	4-20 mA	0.75
65-CHLO-PMP-102 65-CHLO-PMP-103	12.5% Sodium Hypochlorite	2	60	4.5/90	75	90 VDC	4-20 mA	1.0

   5. Pump Gearbox Drive:
      a. Pump gear box shall be constructed of steel and nodular iron and be water resistant and suitable for outdoor installation. Pump and gear box housing shall be coated in high solids epoxy.
      b. Gear box shall be oil bath lubricated.
      c. Identify each pump with a corrosion resistant nameplate, securely affixed in a conspicuous location. Nameplate information to include pump tag number, equipment model number, flow capacity, output pressure and electrical data.
      d. All fasteners shall be Type 316 stainless steel.
   6. Drive and Motor:

a. Type: Each chemical metering pump shall be motor-driven through a flexible coupling or direct connected to the pump if manufacturer's standard. Pumps and motors shall be mounted on floor mountable base plates.
   1) Couplers: Manufacturers: One of the following or equal:
      a) Dodge, Para-flex.
      b) Falk, Type WA.

b. Each pump shall be equipped with a variable speed drive (VSD). The VSD shall be an SCR-DC variable speed drive. The drive shall be suitable for continuous heavy-duty service and shall be suitable for controlling the motor to be furnished. The SCR-DC variable speed drive shall be Baldor Type BC.

c. The pump supplier shall provide each SCR drive with the required input-output capabilities for installation in the control panels furnished, installed, and specified in DIVISION 16 and DIVISION 17, and indicated on the Drawings. The drive shall be rated for operation in an ambient temperature of up to 50 degrees C.

d. The drive shall provide motor overload protection, transient voltage protection, linear acceleration adjustment, adjustable current limit controller, and have 20:1 constant torque speed range.

e. The drive shall respond automatically to a remote setpoint speed signal (4-20 mA). The drive shall provide a 4-20 mA speed signal output proportional to armature voltage for remote indication. The speed signal output shall be measured independently of the remote setpoint speed signal. The drive shall also receive a remote start/stop signal and provide discrete signals for pump, failure alarm, high-pressure alarm, diaphragm leak alarm, position of local/remote switch, speed indication, and run indication. The manufacturer shall furnish required additional components for the drive to function as described herein and shown on the Drawings.

f. The motor shall have TEFC enclosure, permanent magnet type, 90-volt armature rating, with integral tachometer and horsepower not less than the minimum specified rating. Motor shall have a thermostat for high temperature shutdown. Motor shall be manufactured by same manufacturer of SCR drive.

g. The motor brushes shall have tinned leads.

h. The motor and SCR drive supplier shall carefully review the intended application of the variable speed drive and certify in writing that sizes provided are adequate for continuous or intermittent operations (whichever is the most severe operating condition).

7. Liquid End:
   a. Pumps with flat composite mechanically activated diaphragms shall be Teflon faced, fiber reinforced and bonded to an elastomeric support with a steel backing plate.
   b. Pumps with tubular hydraulically actuated diaphragms shall be Teflon lined. The tubular diaphragm shall be isolated from the reciprocating piston by a hydraulically actuated flat piston hydraulic cylinder actuator. There shall be no mechanical connection between the diaphragms and the actuating push rod.
   c. The liquid end shall be sealed by means of an O-ring of material compatible with sodium hypochlorite solution.

d. The liquid end shall provide integral sight flow indication via clear PVC, single ball, cartridge type check valves. Check valves shall compression seal to the pump head and pipe connections via an O-ring seal.
e. A secondary diaphragm shall seal the liquid end completely from the gear box and drive unit, preventing cross contamination.
f. Sodium hypochlorite pumps shall be equipped with an off-gassing valve.
g. The liquid end of each metering pump shall be fitted with a leak detection system to detect early stage diaphragm failure. The detection system shall be an electro optical sensor, mounted on the liquid end in a NEMA 4X enclosure. Upon actuation, the leak detector shall STOP the pump, light a locally visible LED, and sound a remote alarm.

8. Control System:
   a. Provide control system with equipment protective devices for safe operation in a local control panel and with remote inputs and outputs as indicated on the P&ID Drawings.
   b. Stroke length shall be manually adjustable from 1 to 100 percent by means of a 10 turn micrometer stroke length adjustment knob, indicating in 0.25 percent increments.
   c. Provide separate NEMA 4X, 316 stainless steel, chemical feed pumps Local Control Panels, which shall include controls for the chemical feed system. A total of two (2) control panels will be required.
   d. Panel shall be located near the feed pumps as indicated on the Drawings.
   e. Control panels shall be as specified in Sections 16135 and 17050.
   f. Provide a sunshade for the entire panel if located outside.

C. Calibration Columns:
1. Furnish and install calibration columns, one for each chemical metering pump, on the inlet line as indicated on the Drawings and specified herein. The column shall be translucent and graduated for chemical pump calibration operations. Provide a top cap threaded connection with vent piped to the floor to prevent entry of foreign materials and to direct spillage or overflow.
2. Materials shall be compatible with the associated chemical and concentration and suitable for outdoor use and exposure.
3. End Connection: Threaded.
4. Capacity:

Tag No.	Service	Graduation Volume (mL)	Graduation Scale (mL)
65-DCLO-PMP-101 65-DCLO-PMP-102	40% Sodium Bisulfite	1,000	5
65-CHLO-MP-102 65-CHLO-PMP-103	12.5% Sodium Hypochlorite	3,200	5

D. Pulsation Dampeners, as required:
1. Pulsation dampeners.

2. Air or gas charged, double diaphragm, with gas charge valve and gas pressure gauge graduated from 0 to 150 psi.
3. Pulsation dampener shall allow no less than 6 percent fluctuation in pressure.
4. Materials shall be compatible with the associated chemical and concentration and suitable for outdoor use and exposure.
5. Manufacturer: One of the following or equal:
   a. Blacoh.

E. Pressure Gauges, Switches and Diaphragm Seals:
1. Pressure Switches: As specified in Section 17403.
2. Pressure Gauge: As specified in Section 17404.
3. Diaphragm Seal: As specified in Section 17401, except as modified herein:
   a. Materials shall be compatible with the associated chemical and concentration and suitable for outdoor use and exposure.
   b. Shutoff valve shall be provided.

F. Diaphragm Backpressure and Pressure Relief Valves:
1. Ported to serve as either a backpressure valve or a pressure relief valve.
2. Relief valve shall be plumbed back to the pump suction on the non-pump side of the pump suction isolation valve, to avoid spillage unless otherwise noted on Drawings.
3. Adjustable pressure range of 25 to 175 psi.
4. Materials shall be compatible with the associated chemical and concentration and suitable for outdoor use and exposure.
5. Relief Setpoint: Externally adjustable without removing valve from piping system. Set valve to open at 10 pounds per square inch more than pump discharge pressure at operating point, or as indicated on the Drawings.
6. Manufacturer: One of the following or equal:
   a. Plast-O-Matic.
   b. Griffco.

G. Degassing Valves:
1. Furnish and install degassing valves on the sodium hypochorite chemical metering pump discharge lines as indicated on the Drawings.
2. Degassing valve shall be installed as recommended by the manufacturer with vent piping directed to the floor.
3. All wetted materials must be compatible with the pumped liquid.
4. Manufacturer: The degassing valves shall be manufactured by Plast-O-Matic Model DGV and supplied by the pump manufacturer.

H. Control System:
1. Provide control system with equipment protective devices for safe operation in a local vendor control panel (VCP), with remote inputs and outputs as indicated on the P&ID Drawings to provide required control functions.
2. Provide separate NEMA 4X, 316 stainless steel, chemical feed pumps Local Control Panels, which shall include controls for the entire chemical storage and feed system.
3. Panel shall be located near the feed pumps as indicated on the Drawings.
4. Control panels shall be as specified in Section 16135.
5. Provide a sunshade for the entire panel if located outside.

PART 3 EXECUTION

3.01 EXAMINATION AND PREPARATION

A. The OWNER shall inspect all equipment and materials against approved Shop Drawings at time of delivery. Equipment and materials damaged or not meeting requirements of the approved Shop Drawings shall be immediately returned to the SUPPLIER for replacement or repair.

B. Equipment and materials shall be stored in a dry location and protected from the elements according to the Supplier's instructions.

C. Equipment and materials shall be handled in an approved manner according to the Supplier's instructions.

3.02 INSTALLATION

A. Installation of the metering pumps and appurtenances shall be performed by a licensed contractor in the state of Arizona, and shall be in accordance with the Drawings and with the Supplier's recommendations. Conflicts of information shall be called to the attention of the ENGINEER.

B. The concrete bases shall be poured up to one inch below the metal bases, legs, or soleplates. Equipment legs or base plates shall be accurately shimmed to grade and the spaces between filled with an approved nonshrink grout. After the grout has reached its initial set, exposed edges shall be cut back two inches and the edges neatly finished with cement mortar. Where channel base plates are used, the void inside the channel shall be filled with nonshrink mortar and the open ends plastered with cement mortar.

C. Support piping independent of equipment. Equipment shall be free from all loads and stresses induced by the piping.

D. All equipment including motors, belts and drives shall be aligned to the best industrial standards. Field check and adjust all equipment alignments in the presence of the ENGINEER.

E. Inspect all equipment before installation, if damaged, notify the ENGINEER promptly. Do not install damaged equipment until repairs are made in accordance with written instruction and approval by the ENGINEER.

F. Make all electrical connections in conformance with the requirements of the electrical Specifications.

3.03 START UP SERVICES AND TESTING

A. Verify that structures, equipment, pumps, and motors are compatible for an efficient system.

B. Make equipment adjustments required to place system in proper operating condition.

C. Testing:
   1. Test the chemical feed system equipment for proper operation in the presence of the OWNER and ENGINEER.
   2. If the feed system fails to meet any of the specified performance requirements, modify and/or replace defective equipment until it meets specified requirements. Retest system to verify satisfactory operation.
   3. Furnish all testing equipment and devices required.

D. Demonstrate the accuracy of each metering pump using job supplied calibration column.

E. Start-Up Field Services:
   1. Retain, for a period of not less than two days for installation factory, trained representatives of the manufacturer of each component with demonstrated ability and experience in the installation and operation of the equipment. For each installation, the representative shall perform the services listed below:
      a. Inspect the completed installation and prepare an inspection report.
      b. Test, calibrate, and adjust all components for optimum performance.
      c. Assist in initial start up and field testing.
      d. Instruct OWNER's personnel in the operation and user maintenance of all components. Conduct a training seminar at the site.
      e. Supervise the correction of any defective or faulty work before and after acceptance by OWNER.

F. Chemical Feed Pump Manufacturer's Field Services:
   1. Retain, for a period of not less than one day, factory-trained representatives of the dosing pump manufacturer with demonstrated ability and experience in the installation and operation of the dosers. The representative shall perform the services listed below:
      a. Inspect the completed installation and prepare an inspection report.
      b. Test, calibrate and adjust all components for optimum performance.
      c. Assist in initial start up and field testing.
      d. Instruct OWNER's personnel in the operation and user maintenance of all components. Conduct a training seminar at the site.
      e. Supervise the correction of any defective or faulty work before and after acceptance by OWNER.

END OF SECTION

SECTION 11312S

SAMPLE PUMPS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Self-priming sample pumps.

1.02 SYSTEM DESCRIPTION

A. Centrifugal self-priming, jet pump with components: Pump, driver, bearings, seals base plates, and other items as required for a complete and operational system.

B. Provide jet pumps, drivers, and other components capable of intermittent or continuous operation while pumping specified fluid; loss of prime and possible siphoning of liquid from the pump casing shall be considered in design of the self-priming features.

C. Design requirements:
   1. Pump performance characteristics: As specified in the Pump Schedule.
   2. Motor characteristics: As specified in the Pump Schedule.

1.03 SUBMITTALS

A. Submit as specified in Section 15050.

B. O&M manuals shall be submitted in accordance with Section 01782 prior to delivery of equipment to the job site. No payment will be processed for this equipment until O&M manuals have been submitted for approval.

1.04 DELIVERY, STORAGE, AND HANDLING

A. As specified in Section 15050.

1.05 PROJECT CONDITIONS

A. Environmental requirements: As specified in Section 15050.

1.06 WARRANTY

A. As specified in Section 15050.

1.07 MAINTENANCE

A. Special tools: For each type or size of pump specified, provide 1 set of all special tools required for complete assembly or disassembly of all pump system components.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Pumps:
   1. Gould's Pumps, Inc., JS Model.

2.02 GENERAL PUMP CONSTRUCTION

A. Type: Industrial (heavy) duty, self-priming type jet pumps meeting performance design requirements and features as specified in this Section.

2.03 PUMP CASINGS

A. Type: 1 piece with integrally cast suction and discharge nozzles.

B. Material: Cast iron.

C. Construction: Of sufficient strength, weight, and thickness to provide accurate alignment, prevent excessive deflection, and support drive motor.

D. Discharge: 1-inch NPT, centered on the casing top.

E. Suction: 1-1/4-inch NPT, centered on casing, horizontally centered.

F. Design working pressure: 125 psig.

G. Vent and traps:
   1. Provide casings with threaded low point drain, initial priming fill vent, and clean-out plug on casing. Install pipe nipple with threaded gate valve and hose adaptor in priming vent.

2.04 IMPELLERS

A. Type: Enclosed.

B. Material: Glass filled urethane.

C. Design impeller and volute for automatic unattended self-priming and repriming with a dry suction leg and without reliance on a suction check valve to maintain prime.

D. Method of securing to shafts: Threaded, readily removable without use of special tools.

E. Diffuser wear ring:
   1. Material: Stainless steel.

2.05 SHAFT

A. Material: Stainless steel.

B. Impeller attachment: Threaded for securing impeller.

C. Pump shaft seal:
   1. Single mechanical type.
   2. Carbon/ceramic seal faces.
   3. BUNA elastomers.
   4. Stainless steel cage and spring.

2.06 SUPPORTS, PEDESTALS, AND BASEPLATES

A. Materials: Cast iron or steel.

B. Configuration: Allow easy access to stuffing boxes, bearing frames, and couplings.

2.07 DRIVERS

A. Horsepower:
   1. As scheduled.
   2. Listed driver horsepower is the minimum to be supplied. Increase driver horsepower if required to prevent driver overload while operating at any point of the supplied pump operating head-flow curve including runout. However, electrical equipment is sized for scheduled horsepower.

B. Motors: Provide high efficiency motors with characteristics as scheduled.

2.08 FINISHES

A. Prepare surfaces and apply protective finishes as specified in Section 09960.

PART 3 EXECUTION

3.01 INSTALLATION

A. All lubricants shall be per Section 01600.

3.02 FIELD QUALITY CONTROL

A. Suction lift: At rated design point pump speed, test reprime lift (the static head from water surface to suction centerline):
   1. Internal suction check valve removed for test; reinstall after successful reprime testing.
   2. Add temporary 10-foot long, 1-inch air vent on discharge piping between pump discharge flange and discharge piping check valve; leave vent open to atmosphere during reprime testing; remove and plug vent at end of testing.
   3. Repeat reprime cycle test 5 times to demonstrate consistent reprime ability.

3.03 MANUFACTURER'S FIELD SERVICES

A. Complete installation, testing, start-up, and certification as specified in Sections 01756, 15050, and 15958.

3.04 PUMP SCHEDULE

Tag Numbers	UV-PMP-101, EFF-PMP-101
General Characteristics	
Service	
Manufacturer's Model Number	J5S
Minimum Pumped Fluid Degrees Fahrenheit	50
Normal Pumped Fluid Degrees Fahrenheit	70
Maximum Pumped Fluid Degrees Fahrenheit	85
Pump Characteristics	
Impeller Type	Closed
Shaft Seal Type	Single Mechanical
Maximum Pump Revolutions per Minute	3,600
Rated Design Point (at maximum revolutions per minute):	
Flow, gallons per minute	17.5
Suction lift, feet	5
Discharge pressure, psi	20
Required Condition 2 (at maximum revolutions per minute):	
Flow, gallons per minute	15.7
Suction lift, feet	10
Discharge pressure, psi	20
Required Condition 3 (at maximum revolutions per minute):	
Flow, gallons per minute	13.7
Suction lift, feet	15
Discharge pressure, psi	20
Other Conditions:	
Maximum suction static lift, feet	22
Driver Characteristics	
Driver Type	Motor
Minimum Driver Horsepower	1/2
Maximum Driver, rpm	3,600
Motor Characteristics (when motor is driver type)	
Specification Section	16222
Service Factor	1.15
Motor Voltage/Phases/Hertz	115/230/1/60
Enclosure Type	ODP
Field Quality Control Testing	
Performance Test Level	1

END OF SECTION

SECTION 13206A

FIBERGLASS REINFORCED PLASTIC ABOVEGROUND STORAGE TANKS

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes: Fiberglass reinforced plastic aboveground storage tanks for storage of sodium bisulfite.

1.02 REFERENCES

A. American Society of Mechanical Engineers (ASME):
   1. ASME/RTP-1, Reinforced Thermoset Plastic Corrosion Resistant Equipment.

B. American National Standards Institute/American Society of Mechanical Engineers (ANSI/ASME):
   1. B16.1 - Cast Iron Pipe Flanges and Flanged Fittings, Class 25, 125, 250 and 800.
   2. B16.5 - Pipe Flanges and Flanged Fittings.

C. ASTM International (ASTM):
   1. D 2240 - Test Method for Rubber Property - Durometer Hardness
   2. D 3299 - Specification for Filament-Wound Glass Fiber Reinforced Thermoset Resin Chemical-Resistant Tanks
   3. D 4097 - Specification for Contact-Molded Glass-Fiber-Reinforced Thermoset Resin Chemical-Resistant Tanks.

D. International Code Council (ICC):
   1. International Building Code (IBC).

1.03 DESIGN CRITERIA

A. Design tanks in accordance with the latest edition of ASTM 3299, and follow the procedures and methods, and utilize the equations and formulas, and incorporate safety factors and allowable design stresses and strains set forth in ASME/RTP-1 and other design requirements as specified in Section 06608. The tanks will not be required to have ASME/RTP-1 stamp.

B. Tanks sized as indicated in Tank Schedule 3.02 and on the Drawings.

C. Tank Top and bottom types shall be as indicated in Tank Schedule 3.02 and on the Drawings.

D. All tanks specified to have flat bottoms shall have an interior 1/4 inch per foot slope to drain unless otherwise noted.

E. Ambient Temperatures: 25 to 122 degrees Fahrenheit.

F. Static head of contents in accordance with specific gravity indicated in Tank Schedule 3.02.

G. Chemical Environment: Product shall be resistant to chemical service indicated in Tank Schedule 3.02.

H. All tank capacities noted in Tank Schedule 3.02 shall include only the volume in the straight shell. The inclusion of dished tops as additional capacity is not acceptable.

I. Nozzle locations as indicated on the Drawings.

J. Fire retardancy for Class I fire rating required.

K. Seismic design criteria shall be as specified in Section 01612.

L. Wind design criteria shall be as specified in Section 01614.

M. Tank Top Design Criteria: Live load of 20 lb/sf or a concentrated load of 250 pounds.

N. Support conditions as indicated on the Drawings.

O. Fittings: Nozzles, manholes, and accessories as indicated on the Drawings.

1.04 SUBMITTALS

A. Submit as specified in Section 06608, Fiberglass Reinforced Plastic.

B. Calculations demonstrating compliance with wind and seismic criteria sealed and signed by a registered Structural Engineer licensed in the State of Arizona. Anchor bolt calculations shall account for edge distances resulting from tank pad size on drawings.

1.05 QUALITY ASSURANCE

A. Manufacturer Qualifications: Manufacturer of proposed corrosion resistant fiberglass reinforced plastic structures for a minimum of 5 years with satisfactory performance record as specified in Section 06608.

B. The manufacturer approved installer shall have installed products of similar fiberglass reinforced plastic equipment on a minimum of 5 projects with a satisfactory performance record.

1.06 IDENTIFICATION

A. The chemical tanks shall be identified with the health, flammability and reactivity of hazardous materials as required by codes, and as specified in Section 10400.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. One of the following or equal:
   1. Palmer Industrial Products, Garden City, KS.
   2. Ershigs, Inc., Bellingham, WA.
   3. Tankinetics, Harrison, AR.
   4. Xerxes Corporation, Anaheim, CA.
   5. Corrosion Controllers, Inc., Washougal, WA.
   6. Edward Fiberglass, Sedalia, MO.
   7. Diamond Fiberglass, Victoria, TX.

2.02 MATERIALS

A. Materials as specified in Section 06608.

B. Resin:
   1. For Fire Retardant Applications: Premium grade vinyl ester resin as recommended by the resin manufacturer for the specific operating environment. Add antimony trioxide or pentoxide for Class I fire rating to the structural laminate only. Manufacturers: One of the following or equal:
      a. Derakane.
      b. Ashland Hetron.
      c. Interplastic.
      d. Reichhold Dion.
   2. No thixotropic agents shall be used.

C. Minimum Corrosion Liner:
   1. One "C" or synthetic veil such as Nexus 1012.
   2. Remainder 1-1/2 ounce per square foot mat to a total minimum thickness of 0.096 inches on surfaces exposed to the service environment.

D. Ultra Violet Stabilizer: Add to the resin used in the gel coat for exterior surfaces in the type and amount recommended by the resin manufacturer.

2.03 FABRICATION

A. Fabrication Method: Hand lay-up or filament wound at construction with integral molded bottom knuckle in accordance with ASTM D3299 for filament wound vessels or ASTM D4097 for contact molded, hand lay-up vessels as specified in Section 06608.

B. Structural Section with Internal Veil: Prohibited.

C. Color: As selected by OWNER from manufacturer's standard colors.

D. Legs and Tie-Down Lugs: Components laminated onto tank wall shall be Type 316 stainless steel.

E. Anchor Bolts: Type 316 stainless steel, of size and length recommended by tank manufacturer, after reviewing tank pad design drawings, and in accordance with the International Building Code.

F. Flanges:
   1. All flange dimensions, except thickness, and bolting shall conform to the following standards:
      a. Two inch through 24 inch, ANSI B16.5 Class 150.
      b. Thirty inch through 42 inch, ANSI B16.1 Class 125.
   2. Flange faces shall be perpendicular to the centerline of the pipe within 1 degree and shall be flat to plus or minus 1/32 inch up to and including 18 inch equivalent diameter and plus or minus 1/16 inch for equivalent diameters greater than 18 inches. The minimum flange shear thickness shall be 4 times the flange thickness. The flange thickness shall be in accordance with PS 15-69 for 25 pounds per square inch pressure-rated flanges.
   3. Flanges shall be made by hand lay-up construction with nozzle neck and flange made integrally in one piece as specified in Section 06608.
   4. Press molded or filament wound flanges not allowed.
   5. Use 1/8 inch thick full-faced elastomeric gaskets having a Shore A Durometer hardness of 60, within plus or minus 5, as determined by ASTM D 2240 for flanged joints. Elastometer specified by Fabricator to be resistant to chemical environment.

G. Gussets:
   1. Reinforce nozzles, except manways, with plate or conical gussets to match piping.
   2. Conical gussets having comparable strength may be substituted for plate gussets.

H. Reinforcement of Nozzle and Manhole Openings in Vessel Walls:
   1. In accordance with ASTM D 3299 for filament wound vessels or ASTM D 4097 for contact-molded, hand lay-up, vessels as specified in Section 06608.
   2. When reinforcing materials are cut to facilitate placement around an installed nozzle or opening, stagger joints in successive reinforcing layers to avoid overlapping and do not place so that the joints are parallel to the axis of the tank. The principle fiber direction of the woven roving reinforcement (0 degree/90 degree) shall be parallel to the tank axis.

I. Tank Top: As shown on Tank Schedule 3.02.

J. Coordinate sizes and locations of pipe and conduit support clips with CONTRACTOR prior to starting fabrication of tanks. CONTRACTOR and tank manufacturer shall determine locations of pipe support clips. Show these pipe and conduit supports in the tank shop drawing submittal.

K. Quality control and inspection procedures shall be per ASME RTP-1 Level 1 requirements. Supply documentation to demonstrate compliance with this requirement during the Shop Drawing submittal process.

2.04 VESSEL ASSEMBLY

A. All cutouts from the equipment shall be marked, indicating their original location, and retained. All cutouts shall become the property of the OWNER.

B. Do not remove center lines marked on the equipment for use in assembly until after inspection by the ENGINEER.

C. Install flanged nozzles with bolt holes straddling principle center lines of the vessel. For tank tops, nozzle bolt holes straddle radial center lines.

D. When requested, Fabricator shall supply to the OWNER, at the earliest possible time, a template which locates anchor bolt holes within plus or minus 1/8 inch for each vessel.

E. A nonskid surface shall be provided on the exterior surface of the tank top. Silica grit may be applied in conjunction with the final resin coat. Other methods may be submitted.

F. Furnish and overlay on the outside of the equipment a plastic nameplate showing the following information:
   1. Name of manufacturer.
   2. Date of manufacture.
   3. OWNER's purchase order number.
   4. Equipment name/number.
   5. Resin number and manufacturer.
   6. Design pressure and temperature.
   7. Vessel diameter, height, and weight.

G. Butt joints or shell joints shall be in the number and location(s) as indicated on the fabrication drawings. Additional joints are not allowed. Slip joints, "mod joints," or other methods not conforming to the fabrication drawings are not allowed. If joint locations are not indicated on the fabrication drawings, Fabricator shall submit number and location.

H. Allowable tolerances shall be as listed in ASTM D 3299 or ASTM D 4097, except as modified herein or on the fabricator drawings.

I. When joining components, gaps at mating edges shall be limited to 1/4 inch maximum, and misalignment of inside surfaces shall not exceed 1/3 inch of the lesser wall thickness.

J. The outside surface of vessel flat bottoms after assembly shall be flat within plus or minus 1/2 inch. In addition, localized indentations or protrusions shall not exceed plus or minus 1/4 inch within 2 feet.

PART 3 EXECUTION

3.01 TANK INSTALLATION

A. For flat bottom vessels without legs, the foundation must provide full non-elastic support to the flat bottom, through the use of grout, which will allow continuous support even though surfaces may not be flat.

B. All anchor lugs or leg pads shall be set on a 1 inch thick layer of nonshrink grout. Do not use hard shim to fill void between the lugs and foundation.

C. Unless otherwise agreed, independently support all piping so as not to apply loads to the vessel nozzles. Isolate potential load due to thermal expansion of piping from the vessel. During installation, do not force piping into alignment, which can create excessive stresses in the tank.

D. Do not mate raised-face flanges or ring gaskets to full-faced fiberglass reinforced plastic nozzles.

E. Vertically support ladders at the tank foundation or platform. Ladder lugs attached to the vessels shall provide lateral support only.

F. Where tank foundations are cut out to accommodate full bottom drains, fill the cutout area after tank installation with grout or other material that will provide localized support.

3.02 TANK SCHEDULE

A. See attached.

TANK SCHEDULE										
Equipment Tag No. / Asset ID No.	**Equipment Name**	**Specific Gravity**	**Ladder**	**Guardrail**	**Nominal Capacity (gal)**	**Tank Outer Diameter (ft-in)**	**Tank Height(1) (ft-in)**	**Tank Bottom(2)**	**Tank Top**	**Corrosion Allowance**
65-DCLO-TNK-101	Sodium Bisulfite (38%) Bulk Storage Tank No. 1	1.33	Y	N	1,500	Note (3)	Note (3)	Flat	Dome	None

Notes:

(1) Straight side height.

(2) All Tanks specified with flat bottoms shall have an interior 1/4 inch per foot slope to the drain nozzle and flush bottom drain.

(3) See Tank Schedule or Drawing M-03 for details.

END OF SECTION

SECTION 15050

BASIC MECHANICAL MATERIALS AND METHODS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Basic design and performance requirements for mechanical equipment.

1.02 REFERENCES

A. American Gear Manufacturer's Association (AGMA) Standards:
   1. 2001-B88 - Fundamental Rating Factors and Calculation Methods for Involute Spur and Helical Gear Teeth.
   2. 6000-A88 - Specification for Measurement of Linear Vibration on Gear Units.
   3. 6010-E88 - Standard for Spur, Helical, Herringbone, and Bevel Enclosed Drives.
   4. 6019-E89 - Standard for Gear Motors using Spur, Helical, Herringbone, Straight Bevel or Spiral Bevel Gears.
   5. 6025-C90 - Sound for Enclosed Helical, Herringbone, and Spiral Bevel Gear Drives.

B. American Society of Mechanical Engineers (ASME):
   1. PTC 8.2 - Performance Test Code for Centrifugal Pumps.
   2. PTC 10 - Performance Test Code - Compressors and Exhausters.
   3. PTC 17 - Performance Test Code - Reciprocating Internal-Combustion Engines.
   4. PTC 11 - Performance Test Code - Measurement of Shaft Horsepower - Instruments and Apparatus.

C. American Bearing Manufactures Association (ABMA) Standards:
   1. ABMA 9 - Load Ratings and Fatigue Life for Ball Bearings.
   2. ABMA 11 - Load Ratings and Fatigue Life for Roller Bearings.

D. American Petroleum Institute (API):
   1. 682 - Shaft Sealing Systems for Centrifugal and Rotary Pumps.

E. ASTM International (ASTM):
   1. A 36 - Standard Specification for Structural Steel.
   2. A 48 - Standard Specification for Gray Iron Castings.
   3. A 526 - Standard Specification for Steel Sheet, Zinc Coated by the Hot Dip Process, Commercial Quality.
   4. B 61 - Standard Specification for Steam or Valve Bronze Castings.
   5. B 62 - Standard specification for Composition Bronze or Ounce Metal Castings.
   6. E 527 - Standard Practice for Numbering Alloys and Metals (UNS).

F. Hydraulic Institute Standards (HI):
   1. 1.1-1.5 - Centrifugal Pumps - Nomenclature, Definitions, Application, and Operation.
   2. 1.6 - Centrifugal Pump Tests.
   3. 2.1-2.5 - Vertical Pumps - Nomenclature, Definitions, Application, and Operation.
   4. 2.6 - Vertical Pump Tests.
   5. 3.1-1.5 - Rotary Pumps - Nomenclature, Definitions, Application, and Operation.
   6. 3.6 - Rotary Pump Tests.
   7. 4.1-4.6 - Sealless Rotary Pumps - Nomenclature, Definitions, Application, Operation, and Test.
   8. 5.1-1.6 - Sealless Centrifugal Pumps - Nomenclature, Definitions, Application, Operation, and Test.
   9. 6.1-6.5 - Reciprocating Power Pumps - Nomenclature, Definitions, Application, and Operation.
   10. 7.1-7.5 - Controlled Volume Pumps - Nomenclature, Definitions, Application, and Operation.
   11. 9.1-9.5 - Pumps - General Guidelines for Types, Definitions, Application, and Sound Measurement.

1.03 DEFINITIONS

A. Special tools: Tools that have been specifically made for use on unit of equipment for assembly, disassembly, repair, or maintenance.

B. Resonant frequency: That frequency at which a small driving force produces an ever-larger vibration if no dampening exists.

C. Rotational frequency: The revolutions per unit of time usually expressed as revolutions per minute.

D. Critical frequency: Same as resonant frequency for the rotating elements or the installed machine and base.

E. Peak vibration velocity: The root mean square average of the peak velocity of the vibrational movement times the square root of 2 in inches per second.

F. Rotational speed: Same as rotational frequency.

G. Maximum excitation frequency: The excitation frequency with the highest vibration velocity of several excitation frequencies that are a function of the design of a particular machine.

H. Critical speed: Same as critical frequency.

I. Free field noise level: Noise measured without any reflective surfaces (an idealized situation); sound pressure levels at 3 feet from the source unless specified otherwise.

J. Operating weight: The weight of unit plus weight of fluids or solids normally contained in unit during operation.

1.04 SYSTEM DESCRIPTION

A. General:
   1. Provisions specified under each technical equipment specification prevail over and supersede conflicting provisions as specified in this Section.
   2. Provide equipment and parts that are suitable for stresses, which may occur during fabrication, transportation, erection, and operation.
   3. Provide equipment that has not been in service prior to delivery, except as required by tests.
   4. Like parts of duplicate units are to be interchangeable.
   5. When 2 or more units of equipment for the same purpose are required, provide products of same manufacturer.
   6. Equipment manufacturer's responsibility extends to selection and mounting of gear drive units, motors or other prime movers, accessories, and auxiliaries required for proper operation.
   7. When necessary, modify manufacturer's standard product to conform to specified requirements or requirements indicated on the Drawings and contained in Laws and Regulations.

B. Material requirements:
   1. Materials: Suitable for superior corrosion resistance and for services under conditions normally encountered in similar installations.
   2. Dissimilar metals: Separate contacting surfaces with dielectric material.

C. Power transmission systems:
   1. Power transmission equipment: V-belts, sheaves, shaft couplings, chains, sprockets, mechanical variable-speed drives, variable frequency drives, gear reducers, open and enclosed gearing, clutches, brakes, intermediate shafting, intermediate bearings, and U-joints are to be rated for 24 hour-a-day continuous service or frequent stops-and-starts intermittent service, whichever is most severe, and sized with a minimum service factor of 1.5:
      a. Apply 1.5 service factor to nameplate horsepower and torque of prime source of power and not to actual equipment loading.
      b. Apply service factors higher than 1.5 when recommended for continuous 24 hour-per-day operation and shock loadings specified in AGMA 6010-E88, other applicable AGMA standards, or other applicable referenced standards.
      c. When manufacturer recommends service factor greater than 1.5, manufacturer's recommendation takes precedence.

D. Vibration:
   1. Resonant frequency: Ensure there are no natural resonant torsional, radial, or axial frequencies within 25 percent above or below the operating rotational frequencies or multiples of the operating rotational frequencies that may be excited by the equipment design.
   2. Design, balance, and align equipment to meet the vibration criteria specified in Section 15958.

E. Equipment mounting and anchoring:
   1. Mount equipment on cast iron or welded steel bases with structural steel support frames. Utilize continuous welds to seal seams and contact edges between steel members. Grind welds smooth.
   2. Provide bases and supports with machined support pads, dowels for alignment of mating of adjacent items, adequate openings to facilitate grouting, and openings for electrical conduits.
   3. Provide jacking screws in bases and supports for equipment weighing over 1,000 pounds.
   4. Anchorage of equipment to concrete: Perform calculations and determine number, size, type, strength, and location of anchor bolts or other connections.
   5. Provide bolt sleeves for anchor bolts for heavy equipment. Adjust bolts to final location and fill sleeve with non-shrink grout.
   6. Anchorage of equipment to metal supports: Perform calculations and determine number, size, type, strength, and location of bolts used to connect equipment to metal supports.
   7. Design equipment anchorage, supports, and connections for dead load, running loads, loads during start-up, seismic load, and other loads as required for proper operation of equipment.

F. Seismic design:
   1. Design equipment anchorage and related details for seismic design criteria as specified in Section 01612.
   2. For equipment with operating weight of 400 pounds or more, provide calculations for:
      a. Determine operating weight and centroid of equipment.
      b. Calculate forces and overturning moments.
      c. Calculate shear and tension forces in equipment anchorages, supports, and connections.
      d. Design equipment anchorage, supports, and connections based on calculated shear and tension forces.

G. Equipment units weighing 50 pounds or more: Provide with lifting lugs or eyes to allow removal with hoist or other lifting device.

1.05 SUBMITTALS

A. Product data:
   1. For each item of equipment:
      a. Design features.
      b. Load capacities.
      c. Efficiency ratings.
      d. Material designations by UNS alloy number or ASTM Specification and Grade.
      e. Data needed to verify compliance with the Specifications.
      f. Catalog data.
      g. Name plate data.
      h. Clearly mark submittal information to show specific items, materials, and accessories or options being furnished.
   2. Gear reduction units:
      a. Engineering information per applicable AGMA standards.
      b. Gear mesh frequencies.

B. Shop drawings:
   1. Drawings for equipment:
      a. Drawings that include outline drawings, cut-away drawings, parts lists, material specification lists, and other information required to substantiate that proposed equipment complies with specified requirements.
   2. Outline drawings showing equipment, driver, driven equipment, pumps, seal, motor(s) or other specified drivers, variable frequency drive, shafting, U-joints, couplings, drive arrangement, gears, baseplate or support dimensions, anchor bolt sizes and locations, bearings, and other furnished components.
   3. Installation and checkout instructions including leveling and alignment tolerances, grouting, lubrication requirements, and initial start-up procedures.
   4. Wiring, control schematics, control logic diagrams and ladder logic or similar for computer based controls.
   5. Recommended or normal operating parameters such as temperatures and pressures.
   6. Alarm and shutdown setpoints for all controls furnished.

C. Calculations:
   1. Calculations and other information to substantiate equipment base plates, supports, bolts, anchor bolts, and other connections meet minimum design strength requirements and seismic design criteria specified in Section 01612.
   2. Bearing L_{10} life calculations in accordance with ABMA 9 or ABMA 11 calculation methods for drivers, pumps, gears, shafts, motors, and other driveline components with bearings.
   3. Calculations and other information to substantiate that operating rotational frequencies meet the requirements of this Section.
   4. Torsional analysis of power transmission systems: When torsional analysis specified in the equipment sections, provide:
      a. Sketch of system components identifying physical characteristics including mass, diameter, thickness, and stiffness.
      b. Results of analysis including first and second critical frequencies of system components and complete system.
   5. Calculations shall be signed and stamped by a civil or structural engineer registered to practice in the state where the Project is located.

D. Quality control submittals:
   1. Source quality control reports and certified test data as specified in Section 15958.
   2. Submit factory test reports before shipment.
   3. Certified static and dynamic balancing reports for rotating equipment.
   4. Field quality control reports and test data as specified in Section 15958.
   5. Start-up plan: Proposed plan for field-testing equipment as specified in Section 01756.
   6. Certificate of Proper Installation: As specified in Section 01756.
   7. Submit material test reports a specified in the equipment sections.

E. Operation and maintenance manuals:
   1. As specified in Section 01782.
   2. Submit prior to training of OWNER's personnel.
   3. Make available at project site complete copy of manuals for use by field personnel and ENGINEER during start-up and testing of equipment.

4. Include manufacturer and model number of every bearing; include calculated ball pass frequencies of the installed equipment for both the inner and outer raceways.
5. Include motor rotor bar pass frequencies.

F. Project closeout documents: As specified in Section 01770.

1.06 QUALITY ASSURANCE

A. Manufacturer's field service:
1. Furnish services of authorized representative specially trained in installation of equipment:
   a. Visit project site and perform tasks necessary to certify installation.
   b. Furnish Certificate of Proper Installation as specified in Section 01756.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Packing and shipping:
1. Equipment: Pack in boxes, crates, or otherwise protect from damage and moisture, dust, or dirt during shipment, handling, and storage.
2. Bearings: Separately pack or otherwise suitably protect during transport.
3. Spare parts: Deliver in boxes labeled with contents, equipment to which spare parts belong, and name of CONTRACTOR.

B. Storage:
1. Equipment having bearings: Store in enclosed facilities. Rotate units at least once per month or more often as recommended by the manufacturer to protect rotating elements and bearings.
2. Gear boxes: Oil filled or sprayed with rust preventive protective coating.

C. Protection:
1. Equipment: Protect equipment from deleterious exposure.
2. Painted surfaces: Protect against impact, abrasion, discoloration, and other damage.

1.08 PROJECT CONDITIONS

A. Equipment for project is to be suitable for performance in wastewater treatment plant environment and under the following conditions:
1. Ambient Temperatures: 20 to 122 degrees Fahrenheit.
2. Relative Humidities: 5 to 100 percent.
3. Site Elevation: Approximately 1185 feet above mean sea level.

1.09 SEQUENCING AND SCHEDULING

A. Equipment anchoring: Obtain anchoring material and templates or setting drawings from equipment manufacturers in adequate time for anchors to be cast-in-place when concrete is placed.

B. Coordinate details of equipment with other related parts of the Work, including verification that structures, piping, wiring, and equipment components are compatible.

C. General start-up and testing of equipment:
   1. Perform general start-up and testing procedures after operation and maintenance manuals for equipment have been received.
   2. Conduct functional testing of mechanical or electrical systems when each system is substantially complete and after general start-up and testing procedures have been successfully completed.
   3. Functional testing requirements as specified in Sections 01756, 15958, 16950, and 17950 and the equipment sections.

1.10 WARRANTY

A. Warranty: Warrant equipment free of defects in material and workmanship for 1 year from the date of acceptance or date of first beneficial use of the equipment by the OWNER; cover parts and labor.

B. Where an extended warranty beyond 1 year is required by the detailed equipment specification Section, manufacturer's extended warranty shall be issued in the OWNER's name.

1.11 MAINTENANCE

A. Special tools:
   1. When specified, provide special tools required for operation and maintenance.
   2. Mark or tag and list such tools in maintenance and operations instructions. Describe use of each tool.

B. Spare belts:
   1. When spare belts are specified, furnish 1 spare belt for every different type and size of belt-driven unit:
      a. Where 2 or more belts are involved, furnish matched sets.
      b. Identify as to equipment, design, horsepower, speed, length, sheave size, and use.
      c. Package in boxes labeled with identification of contents.

C. Spare parts:
   1. Assume responsibility until turned over to OWNER.
   2. Store in enclosed facilities.
   3. Furnish itemized list and match identification tag attached to every part.
   4. List parts by generic title and identification number.
   5. Furnish name, address, and telephone number of supplier and spare parts warehouse.

PART 2 PRODUCTS

2.01 MATERIALS

A. Ferrous materials:
   1. Steel for Members used in Fabrication of Assemblies: ASTM A 36.
   2. Iron castings: ASTM A 48, tough, close-grained gray iron, free from blowholes, flaws, and other imperfections.
   3. Galvanized steel sheet: ASTM A 526, minimum 0.0635 inch (16 gauge).
   4. Expanded metal: ASTM A 36, 13 gauge, 1/2-inch flat pattern expanded metal.

B. Nonferrous materials:
   1. Stainless steel: Type 304 or 316 as specified. Provide L grade where welding required.
   2. Bronze in contact with liquid: Composition of not more than 2 percent aluminum nor more than 6 percent zinc; UNS Alloy C83600, C92200 or C93700 in accordance with ASTM B 61, B 62, B 505, or B 584, when not specified otherwise.

C. Dielectric materials for separation of dissimilar metals:
   1. Neoprene, bituminous impregnated felt, heavy bituminous coatings, nonmetallic separators or washers, or other materials.

D. Anchors bolts: As specified in Section 05120; minimum 0.5 inch diameter.

E. Non-shrink grout: As specified in Section 03600.

2.02 SHAFT COUPLINGS

A. General:
   1. Type and ratings: Provide nonlubricated type, designed for not less than 50,000 hours of operating life.
   2. Sizes: Provide as recommended by manufacturer for specific application, considering horsepower, speed of rotation, and type of service.
   3. Use: Use of couplings specified in this Section does not relieve CONTRACTOR of responsibility to provide precision alignment of driver-driven units as required by equipment manufacturer and alignment criteria specified elsewhere in this Section.

B. Shaft couplings - close coupled: Shaft couplings for close coupled electric motor driven equipment 1/2 horsepower or larger and subject to sudden torque reversals or shock loading:
   1. Manufacturers: One of the following or equal:
      a. T.B. Woods, Dura-Flex, L-Jaw C-Jaw or G-Jaw.
      b. Lovejoy, S-Flex.
   2. Provide flexible couplings designed to accommodate angular misalignment, parallel misalignment, and end float.
   3. Manufacture flexible component of coupling from synthetic rubber, or urethane.
   4. Provide service factor of 2.5 for electric motor drives and 3.5 for engine drives.
   5. Do not allow metal-to-metal contact between driver and driven equipment.
   6. Examples of loads where sudden torque reversals may be expected:
      a. Reciprocating pumps, blowers, and compressors.
      b. Conveyor belts.
      c. Reversing equipment.

C. Shaft couplings - direct connected: Shaft couplings for direct connected electric motor driven equipment 1/2 horsepower or larger and subject to normal torque, non-reversing applications:
   1. Manufacturers: One of the following or equal:
      a. Rexnord - Falk.
      b. T.B. Woods, Dura-Flex, Sure-Flex or Form-Flex.
   2. Provide flexible couplings designed to accommodate shock loading, vibration, and shaft misalignment or offset.

3. Provide flexible connecting element of rubber and reinforcement fibers.
4. Connect stub shafts through collars or round flanges, firmly keyed to their shafts with neoprene cylinders held to individual flanges by through pins.

D. Spacer couplings: Where cartridge type mechanical seals or non-split seals are specified, provide a spacer type coupling of sufficient length to remove the seal without disturbing the driver or driven equipment unless noted otherwise in the individual equipment specifications.

E. Specialized couplings: Where requirements of equipment dictate specialized features, supply coupling recommended for service by manufacturer.

2.03 STUFFING BOX, SEAL CHAMBER, AND SHAFT SEALS

A. General:
1. Unless otherwise noted in the equipment section, provide cartridge type, double mechanical shaft seals for pumps.
2. Provide a stuffing box large enough for a double mechanical seal.
3. Where packing is specified, provide stuffing box large enough to receive a double mechanical seal.
4. Provide seal or packing flush connections, (3/4 inch size unless another size is indicated on the Drawings). Provide and route leakage drain line to nearest equipment floor drain indicated on the Drawings.
5. For pumps with packing, design packing gland to allow adjustment and repacking without dismantling pump except to open up packing box.
6. Seal or packing flush requirements shall comply with API Standard 682 requirements. Unless otherwise indicated, specified or required by the equipment and seal manufacturers, the following API flushing Plan arrangements shall be utilized as appropriate for the application:
   a. Single seal, clean water applications: Plan 11 (Discharge bypass to seal).
   b. Single seal, vertical pump applications: Plan 13 (Seal bypass to suction).
   c. Single seal, clean hot water (greater than180 degrees Fahrenheit) applications: Plan 23 (Seal cooler and pumping ring).
   d. Single seal, solids, or contaminants containing water applications: Plan 32 (External seal water- see Carollo typical detail # M262).
   e. Double seal applications: Plan 54 (External seal water- see Carollo typical detail # M262).

B. Packing: When specified in the equipment section of the specifications, provide the following type of packing:
1. Wastewater, water, and sludge applications:
   a. Asbestos free.
   b. PTFE (Teflon) free.
   c. Braided graphite.
   d. Manufacturers: One of the following or equal:
      1) Chesterton, 1400.
      2) John Crane Inc., equivalent product.
2. Drinking water service:
   a. Approved by the Food and Drug Administration (FDA) or National Sanitation Foundation (NSF).
   b. Asbestos free.
   c. Material: Braided PTFE (Teflon).

d. Manufacturers: One of the following or equal:
   1) Chesterton, 1725.
   2) John Crane, Inc., equivalent product.

C. Mechanical seals: Provide seal types specified in the equipment sections and as specified herein.
   1. Provide seal types meeting the following requirements:
      a. Balanced hydraulically.
      b. Spring: Stationary, out of pumping fluid, Hastelloy C; Type Elgiloy or 17-7 PH stainless steel for split seals.
      c. O-ring: Viton 747.
      d. Gland: Type 316L stainless steel.
      e. Set screws: Type 316L stainless steel.
      f. Faces: Reaction bonded, Silicon Carbide.
      g. Seal designed to withstand 300 pounds per square inch gauge minimum differential pressures in either direction; no requirement for seal buffer pressure to be maintained when pump is not operational even though process suction head may be present in pump.
   2. Cartridge type single mechanical: manufacturers: One of the following or equal:
      a. Chesterton, S10.
      b. John Crane, 5610 Series.
   3. Cartridge type double mechanical: Manufacturers: One of the following or equal:
      a. Chesterton, S20.
      b. John Crane, 5620 Series.
   4. Split face single mechanical: Manufacturers: One of the following or equal:
      a. Chesterton, 442.
      b. John Crane, 3710.

2.04 GEAR REDUCTION UNITS

A. Type: Helical or herringbone, unless otherwise specified.

B. Design:
   1. Made of alloys treated for hardness and for severe service.
   2. AGMA Class II service:
      a. Use more severe service condition when such is recommended by unit's manufacturer.
   3. Cast iron housing with gears running in oil.
   4. Anti-friction bearings.
   5. Thermal horsepower rating based on maximum horsepower rating of prime mover not actual load.
   6. Manufactured in accordance with applicable AGMA standards.

C. Planetary gear units are not to be used.

2.05 BELT DRIVES

A. Sheaves:
   1. Separately mounted on bushings by means of at least 3 pull-up bolts or cap tightening screws.

2. When 2 sheave sizes are specified, provide separate belts sized for each set of sheaves.
3. Statically balanced for all; dynamically balanced for sheaves that operates at peripheral speed of more than 5,500 feet per minute.
4. Key bushings to drive shaft.

B. Belts: Anti-static type when explosion-proof equipment or environment is specified.

C. Manufacturers: One of the following or equal:
1. Dodge, Dyna-V belts with matching Dyna-V sheaves and Taper-Lock bushings.
2. Wood's, Ultra-V belts with matching Sure-Grip sheaves and Sure-Grip bushings.

2.06 BEARINGS

A. Type: Oil or grease lubricated, ball or roller antifriction type, of standard manufacture.

B. Oil lubricated bearings: Provide either pressure lubricating system or separate oil reservoir splash type system:
1. Size oil lubrication systems to safely absorb heat energy generated in bearings when equipment is operating under normal conditions and with the ambient temperature 15 degree Fahrenheit above the maximum ambient temperature specified elsewhere in this Section.
2. Provide an external oil cooler when required to satisfy the specified operating conditions. Provide air cooled system if a water-cooling source is not indicated on the Drawings. Equip oil cooler with a filler pipe and external level gauge.

C. Grease lubricated bearings, except those specified to be factory sealed: Fit with easily accessible grease supply, flush, drain, and relief fittings.
1. Lubrication lines and fittings:
a. Lines: Minimum 1/4-inch diameter stainless steel tubing.
b. Multiple fitting assemblies: Mount fittings together in easily accessible location.
c. Use standard hydraulic type grease supply fittings:
1) Manufacturers: One of the following or equal:
a) Alenite.
b) Zurk.

D. Ratings: Rated in accordance with ABMA 9 or ABMA 11 for L_{10} rating life of not less than 50,000 hours:
1. Higher ratings, when specified in other Sections, supersede preceding requirement.

2.07 SAFETY GUARDS

A. Drive assemblies: Enclose sprockets, belts, drive chains, gearings, couplings, and other moving parts on drive assemblies in safety enclosures that are in compliance with applicable Laws and Regulations.

B. Shafts: Provide guards that protect personnel from rotating shafts or components within 7.5 feet of floors or operating platforms.

C. Hot surfaces: Insulate all surfaces with normal operating temperatures above 120 degrees Fahrenheit when surface is within 7.5 feet height from any operating floor or level; insulation thickness such that temperature is below 120 degrees Fahrenheit; cover insulation with moisture-proof protective jacket; insulation Type 3 and jacket Type 3 as specified in Section 15082.

D. Guard requirements:
   1. Allow visual inspection of moving parts without removal.
   2. Allow access to lubrication fittings.
   3. Prevent entrance of rain or dripping water for outdoor locations.
   4. Size belt and sheave guards to allow for installation of sheaves 15 percent larger and addition of 1 belt.

E. Materials:
   1. Sheet metal: Carbon steel, 12 gauge minimum thickness, hot-dip galvanized after fabrication.
   2. Fasteners: Type 304 stainless steel.

2.08 SPRING VIBRATION ISOLATORS

A. Design requirements:
   1. Telescopic top and bottom housing with vertical stabilizers to resist lateral and vertical forces.
   2. Use steel coil springs.
   3. Design vibration isolators in accordance with seismic design criteria as specified in Section 01612.

B. Performance requirements: Minimum spring deflection of 1 inch under static load and capable of limiting transmissability to 10 percent maximum at design operating load.

C. Manufacturers: One of the following or equal:
   1. California Dynamics Corporation, Type RJSD.
   2. Mason Industries, equivalent product.

D. Materials:
   1. Fabricate isolators using welded steel or shatterproof ductile iron in accordance with ASTM A 536 Grade CS-45-12.
   2. Spring steel: ASTM A 125.

2.09 WARNING SIGNS

A. Provide for equipment that starts automatically or remotely.

B. Material and size: Metal as specified in Section 10400.

C. Colors: Black lettering on yellow background.

D. Text: As specified in Section 10400.

2.10 FABRICATION

A. Structural steel members: As specified in Section 05120.

B. Nameplates:
   1. Engraved or stamped on Type 304 stainless steel and fastened to equipment at factory in an accessible and visible location.
   2. Indicate following information as applicable:
      a. Manufacturer's name.
      b. Equipment model number and serial number.
      c. Maximum and Normal rotating speed.
      d. Horsepower.
      e. Rated capacity.
      f. Service class per applicable standards.
   3. Nameplates for pumps: Include:
      a. Rated total dynamic head in feet of fluid.
      b. Rated flow in gallons per minute.
      c. Impeller, gear, screw, diaphragm, or piston size.
   4. Gear reduction units: Include:
      a. AGMA Class of service.
      b. Service factor.
      c. Input and output speeds.

C. Bolt holes in equipment support frames: Do not exceed bolt diameter by more than 25 percent, up to limiting maximum diameter oversize of 1/4 inch.

D. Shop finishing:
   1. Provide factory and field coating as specified in Section 09960. If not specified in Section 09960, provide coating as follows:
      a. Bases and support frames in contact with concrete or other material: Coat contacting surfaces with minimum of 2 coats of zinc chromate primer before installation or grouting.
      b. Shop primer for steel and iron surfaces, unless specified otherwise:
         1) Manufacturers: One of the following or equal:
            a) Ameron, Amercoat 185 Universal Primer.
            b) Cook, 391-N-167 Barrier Coat.
            c) Kop-Coat, Pug Primer.
            d) Tnemec, 37-77 Chem-Prime.
            e) Valspar, 13-R-28 Chromox Primer.
      c. Coat machined, polished, and nonferrous surfaces which are not to be painted with rust-preventive compounds:
         1) Manufacturers: One of the following or equal:
            a) Houghton, Rust Veto 344.
            b) Rust-Oleum, R-9.
      d. Coating for ferrous metal surfaces, except stainless steel: High solids polyamine epoxy.
      e. Finish painting of motors: Shop finish paint with manufacturer's standard coating, unless otherwise specified in Section 09960.

2.11 SOURCE QUALITY CONTROL

A. As specified in Section 15958 for testing requirements and the individual equipment sections of the Specifications.

PART 3 EXECUTION

3.01 EXAMINATION

A. Inspect all components for shipping damage, conformance to specifications, and proper torques and tightness of fasteners.

3.02 PREPARATION

A. Metal work embedded in concrete:
   1. Accurately place and hold in correct position while concrete is being placed.
   2. Clean surface of metal in contact with concrete immediately before concrete is placed.

B. Concrete surfaces designated to receive grout:
   1. Heavy sandblast concrete surface in contact with grout.
   2. Clean surfaces of sandblasting sand, grease, oil, dirt, and other foreign material that may reduce bonding of grout.
   3. Concrete saturation: Saturate concrete with water. Concrete shall be saturated surface damp at time grout is placed.

C. Field measurements:
   1. Prior to fabrication of equipment, take measurements for installation of equipment and verify dimensions indicated on the Drawings. Ensure equipment and ancillary appurtenances fit within available space.

3.03 INSTALLATION

A. Install equipment in accordance with manufacturer's installation instructions and recommendations.

B. Lubrication lines and fittings:
   1. Lines from fittings to point of use: Support and protect.
   2. Fittings:
      a. Bring fittings to outside of equipment in manner such that they are readily accessible from outside without necessity of removing covers, plates, housings, or guards.
      b. Mount fittings together wherever possible using factory-mounted multiple fitting assemblies securely mounted, parallel with equipment lines, and protected from damage.
      c. Fittings for underwater bearings: Bring fittings above water surface and mount on edge of structure above.

C. Alignment of drivers and equipment:
   1. Where drive motors or other drivers are connected to driven equipment by flexible coupling, disconnect coupling halves and align driver and equipment after complete unit has been leveled on its foundation.
   2. Comply with procedures of appropriate Hydraulic Institute Standards, AGMA Standards, alignment tolerances of equipment manufacturers and the following requirements to bring components into angular and parallel alignment:
      a. Maximum total coupling offset (not the per plane offset): Not to exceed 0.5 mils per inch of coupling length for spacer couplings based on coupling length (not dial separation).

b. Utilize jacking screws, wedges, or shims as recommended by the equipment manufacturer and as specified in the equipment sections.

3. Use reverse-indicator arrangement dial type or laser type alignment indicators: Mount indicators on the driver/coupling flange and equipment/coupling flange. Alignment instrumentation accuracy shall be sufficient to read angular and radial misalignment at 10 percent or less of the manufacturer's recommended acceptable misalignment.
4. Alignment and calculations shall include measurement and allowance for thermal growth, spacer coupling length, indicator separation, and axial spacing tolerances of the coupling.
5. When alignment satisfies most stringent tolerance of system components, grout between base and foundation. Allow minimum 48 hours for grout to harden. After grout hardens, remove jacking screws, tighten anchor bolts and other connections, and recheck alignment. Correct alignment as required.
6. After operational testing is complete, dowel motor or drivers and driven equipment. Comply with manufacturer's instructions.

D. Grouting equipment bases:
1. Grout equipment with non-shrink grout as specified in Section 03600.
2. Comply with manufacturer's installation instructions for grouting spaces, and tolerances for level and alignments, both vertical and horizontal.
3. Grout equipment bases after piping connections are complete and in alignment with no strain transmitted to equipment.
4. Grout base when equipment is leveled and in alignment.
5. Place grout, filling voids under equipment bases and other supports including recesses between anchor bolts and sleeves:
a. Extend grout to edge of bases or bedplates and bevel at 45 degrees around units.
b. Finish surfaces with slope that prevents ponding water within grouted areas.

E. Special techniques: Use applicable special tools and equipment, including precision machinist levels, dial indicators, and gauges as required in equipment installations.

F. Tolerances:
1. Completed equipment installations: Comply with requirements for intended use and specified vibration and noise tolerances.

G. Warning signs: Mount securely with stainless fasteners at equipment that can be started automatically or from remote locations.

3.04 FIELD QUALITY CONTROL

A. Test equipment as specified in Section 15958 and the individual equipment Section of the Specifications.

B. Perform operational testing as required by Section 01756.

3.05 MANUFACTURER'S REPRESENTATIVE

A. Field checkout: Before field-testing and start-up, provide services of factory-trained field service representative to certify the equipment has been installed, aligned, and checked in accordance with the manufacturer's instructions and the Specifications.

B. Testing: Provide services of factory trained representative to observe and advise the CONTRACTOR during field quality control testing.

C. Training: When training is specified, provide services of factory-trained representative to perform training as specified in Section 01756.

END OF SECTION

SECTION 15052

BASIC PIPING MATERIALS AND METHODS

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes: Basic piping materials and methods.

1.02 REFERENCES

A. American Society of Testing and Materials (ASTM):
   1. A 53 - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless.
   2. A 106 - Specification for Seamless Carbon Steel Pipe for High-Temperature Service.
   3. D 2240 - Test Method for Rubber Property - Durometer Hardness.

1.03 DEFINITIONS

A. Aboveground Piping: Piping within buildings, tunnels, or other structures without regard to elevation of piping, or exposed piping outside buildings and structures.

B. Underground Piping: Piping actually buried in soil or cast in concrete.

C. Underwater Piping: Piping below tops of walls in basins or concrete tanks containing water.

D. Wet Wall: Wall with water on at least one side.

1.04 SYSTEM DESCRIPTION

A. Piping Drawings:
   1. Except in details, piping is indicated diagrammatically. Not every offset and fitting, or structural difficulty that may be encountered has been indicated on the Drawings. Sizes and locations are indicated on the Drawings.
   2. Perform minor modifications to piping alignment where necessary to avoid structural, mechanical, or other type of obstructions that cannot be removed or changed.
      a. Modifications are intended to be of minor scope, not involving a change to the design concept or a change to the Contract Price or Contract Times.

B. Performance Requirements:
   1. Venting Piping Under Pressure:
      a. Lay piping under pressure flat or at a continuous slope without air traps, unless otherwise indicated on the Drawings.
      b. Install plug valves as air bleeder cocks at high points in piping. Provide one-inch plug valves for water lines, and two inch plug valves for sewage and sludge lines, unless otherwise indicated on the Drawings.

c. Provide additional pipe taps with plug cocks and riser pipes along piping as required for venting during initial filling, disinfecting, and sampling.
d. Before piping is placed into service, close plug valves and install plugs. Protect plugs and plug valves from corrosion in accordance with Section 09960.

2. Restraining Piping:
   a. Restrain piping at valves and at fittings where piping changes direction, changes sizes, and at ends.
      1) When piping is underground, use mechanical restraints.
      2) When piping is aboveground or under water, use mechanical or structural restraints.
      3) Determine thrust forces by multiplying the nominal cross sectional area of the piping by design test pressure of the piping.
   b. Provide restraints with ample size to withstand thrust forces resulting from test pressures. During testing, provide suitable temporary restraints where piping does not require permanent restraints.
   c. Place concrete thrust blocks against undisturbed soil. Place concrete so piping joints, fittings, and other appurtenances are accessible for assembly and disassembly.
3. Connections to Existing Piping:
   a. Expose existing piping to which connections are to be made with sufficient time to permit, where necessary, field adjustments in line, grade, or fittings.
   b. Protect domestic water supplies from contamination.
      1) Make connections between domestic water supply and other water systems in accordance with requirements of public health authorities.
      2) Provide devices approved by OWNER of domestic water supply system to prevent flow from other sources into the domestic supply system.
   c. Make connections to existing piping and valves after sections of new piping to be connected have been tested and found satisfactory.
   d. Provide sleeves, flanges, nipples, couplings, adapters, and other fittings needed to install or attach new fittings to existing piping and to make connections to existing piping.
4. Connections to In-service Piping:
   a. Establish procedures and timing in a conference attended by CONTRACTOR, ENGINEER, and OWNER of the in-service piping.
   b. Where operation and maintenance of existing facilities require that a shutdown be made during hours other than normal working hours, perform the related work in coordination with the hours of actual shutdown.
5. Connections at Dissimilar Metals:
   a. Connect ferrous and nonferrous metal piping, tubing, and fittings with dielectric couplings especially designed for the prevention of chemical reactions between dissimilar metals.
   b. Nonferrous metals include aluminum, copper, and copper alloys.

C. Piping Alternatives:
1. Provide piping in accordance with this Section, unless indicated on the Drawings or specified otherwise.
2. Alternative Pipe Ratings: Piping with greater pressure rating than specified may be substituted in lieu of specified piping without changes to the Contract

Price. Piping of different material may not be substituted in lieu of specified piping.

3. Alternative Joint Types: Ductile iron piping with mechanical joints or push-on joints may be substituted in lieu of bell and spigot joints.
4. Valves in Piping Sections: Capable of withstanding specified test pressures for piping sections and fabricated with ends to fit piping.
5. For flanged joints, where one of the joining flanges is raised face type, provide a matching raised face type flange for the other joining flange.

PART 2 PRODUCTS

2.01 ESCUTCHEONS

A. Manufacturers: One of the following or equal:
   1. Dearborn Brass Company, Model Number 5358.
   2. Keeney Manufacturing Company, Model Number 102 or Number 105.
   3. Beaton and Corbin, Model Number 1 or Number 13.

B. Material: Chrome-plated steel plate.

2.02 LINK TYPE SEALS

A. Manufacturers: One of the following or equal:
   1. Calpico, Inc.
   2. Thunderline Corporation, Link-Seal.

B. Characteristics:
   1. Modular mechanical type, consisting of interlocking neoprene or synthetic rubber links shaped to continuously fill the annular space between the pipe and wall opening.
   2. Assemble links solely with stainless steel bolts and nuts to form a continuous rubber belt around the pipe.
   3. Provide a stainless steel or glass reinforced nylon pressure plate under each bolt head and nut. Isolate pressure plate from contact with wall sleeve.

2.03 GASKETS

A. Gaskets for Non-steam Cleaned Ductile Iron and Steel Piping:
   1. Suitable for pressures equal to and less than 150 pounds per square inch gauge, temperatures equal to and less than 250 degrees Fahrenheit, and raw sewage service.
   2. Gasket Material:
      a. Neoprene elastomer with minimum Shore A hardness value of 70.
      b. Reinforcement: Inserted 13 ounce nylon fabric cloth for pipes 20 inch or larger.
      c. Thickness: Minimum 3/32 inch thick for less than 10 inch pipe; minimum 1/8 inch thick for 10 inch and larger pipe.
   3. Manufacturers: One of the following or equal:
      a. Pipe 20 inches in Diameter and Larger:
         1) Garlock, Style 8798.
         2) John Crane, similar product.

b. Pipe Less than 20 inches in Diameter:
   1) Garlock, Style 7797.
   2) John Crane, similar product.

B. Gaskets for Flanged Joints in Polyvinyl Chloride and Polyethylene Piping:
   1. Suitable for pressures equal and less than 150 pounds per square inch gauge, with low flange bolt loadings, temperatures equal and less than 120 degrees Fahrenheit, polymer, chlorine, caustic solutions, and other chemicals, except chemicals which liberate free fluorine including fluorochemicals and gaseous fluorine.
   2. Material:
      a. Teflon enveloped EPDM.
      b. Sealability in accordance with ASTM F37, less than 0.55 millimeters/hr leakage of iso-octane at 1,000 psi gasket load and 9.8 psig fluid pressure.
   3. Manufacturers: One of the following or equal:
      a. ASAHI AV Gasket.
      b. Garlock, similar product.

C. Gaskets for Flanged Joints in Low Pressure Air Piping:
   1. Suitable for pressures equal and less than 150 pounds per square inch gauge, temperatures equal and less than 300 degrees Fahrenheit, and compressed air service.
   2. Material: EPDM elastomer, 1/8 inch thick, 60 Shore hardness, smooth surface.
   3. Manufacturers: One of the following or equal:
      a. Garlock, Style 8314.
      b. John Crane, similar product.

D. Gaskets for Flanged Joints in Ductile Iron, or Steel Water Piping:
   1. Suitable for hot or cold water, pressures equal and less than 150 pounds per square inch gauge, and temperatures equal and less than 160 degrees Fahrenheit.
   2. Material:
      a. Neoprene elastomer, compressed, non-asbestos fiber reinforcement.
   3. Manufacturers: One of the following or equal:
      a. Bluegard, Style 3300.
      b. Garlock.
      c. John Crane, similar product.

2.04 FLANGE ISOLATING CONNECTIONS

A. Isolating Flanges: Isolated flanges shall have boltholes 1/4 inch diameter greater than the bolt diameter.

B. Isolating Flange Sets: Isolating flange sets shall be provided where shown. Each isolating flange set shall consist of an isolating gasket, isolating sleeves and washers and a steel washer. Isolating sleeves and washers shall be one piece when flange bolt diameter is 1-1/2 inches or smaller and shall be made of acetal resin. For bolt diameters larger than 1-1/2 inches, isolating sleeves and washers shall be two-piece and shall be made of polyethylene or phenolic. Steel washers shall be in accordance with ASTM A 325. Isolating gaskets shall be full-face (Type E) and shall have a minimum dielectric strength of 300 volts/mil.

C. Isolating Flange Manufacturers, or equal:
   1. PSI Products, Inc., Burbank, California.
   2. JM Clipper, Red Devil.
   3. Central Plastics Co., Shawnee, OK.

2.05 THREADED ISOLATING CONNECTIONS

A. General: Threaded isolating bushings, unions, or couplings, as appropriate, shall be used for joining threaded pipes of dissimilar metals and for piping systems where corrosion control and cathodic protection are involved.

B. Materials: Threaded isolating connections shall be of nylon, Teflon, polycarbonate, polyethylene, or other nonconductive materials, and shall have ratings and properties to suit the service and loading conditions.

C. Threaded Isolating Connection Manufacturer, or equal:
   1. Central Plastics, Co., Shawnee, OK.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verification of Existing Conditions:
   1. Locate and expose existing structures, piping, conduits, and other facilities and obstructions which may affect construction of underground piping before starting excavation for new underground piping and appurtenances.
   2. Verify sizes, elevations, locations, and other relevant features of existing facilities and obstructions. Determine conflicts for the construction of the new underground piping and appurtenances.
   3. Make piping location and grade adjustments to resolve conflicts between new piping and existing facilities and obstructions.

3.02 WALL AND SLAB PENETRATIONS

A. Provide sleeves for piping penetrations through aboveground masonry and concrete walls, floors, ceilings, roofs, pilasters, columns, piers, and beams unless specified or otherwise indicated on the Drawings.

B. For piping one inch in nominal diameter and larger, provide sleeves with minimum inside diameters of one inch plus outside diameter of piping. For piping smaller than 1 inch in nominal diameter, provide sleeve of minimum twice the outside diameter of piping.
   1. Arrange sleeves and adjacent joints so piping can be pulled out of sleeves and replaced without disturbing the structure.
   2. Cut ends of sleeves flush with surfaces of concrete, masonry, or plaster.
   3. Conceal ends of sleeves with escutcheons where piping runs through floors, walls, or ceilings of finished spaces within buildings.
   4. Seal spaces between pipes and sleeves with link-type seals when not otherwise specified or indicated on the Drawings.

5. Seal openings around piping running through interior walls and floors of chlorine rooms and chlorine storage rooms gastight with synthetic rubber sealing compound.

C. Cast couplings or wall pieces in walls for penetrations of buried rigid piping including cast iron, ductile iron, reinforced concrete, and vitrified clay through structures.
   1. Provide couplings or wall pieces with mechanical push-ons, or similar flexible joints at outside faces of walls.
   2. Provide additional similar joints in piping at transition points between trenches and structure excavations.
   3. For steel piping, single joints may be used in lieu of two joints. Locate single joints outside within 2 feet from outside faces of walls. Use two link seals where seal is used to seal at wet wall sleeves. Mount one seal on the inside face of the wall and the other on the outside face of the wall. Coordinate the inside diameter of the wall sleeve with the size of the seal to provide watertight sealing.

D. Where not indicated on the Drawings, penetrations for conditions other than those specified under the preceding subparagraphs shall be 1 of the 3 types specified in such subparagraphs found by ENGINEER to be the most suitable for the particular conditions.

3.03 EXPOSED PIPING

A. Install exposed piping in straight runs parallel to the axes of structures, unless indicated otherwise.
   1. Install piping runs plumb and level, unless otherwise indicated on the Drawings.
   2. Slope plumbing drain piping with 1/8 inch per foot downward in the direction of flow.

B. Install exposed piping after installing equipment and after piping and fitting locations have been determined.

C. Support piping in accordance with Section 15062. Do not transfer pipe loads and strain to equipment.

D. In addition to the joints indicated on the Drawings, provide unions, flexible couplings, flanged joints, and other types of joints or means which are compatible with and suitable for the piping system, and necessary to allow ready assembly and disassembly of the piping.

E. Assemble piping without distortion or stresses caused by misalignment.
   1. Match and properly orient flanges, unions, flexible couplings, and other connections.
   2. Do not subject piping to bending or other undue stresses when fitting piping. Do not correct defective orientation or alignment by distorting flanged joints or subjecting flange bolts to bending or other undue stresses.
   3. Flange bolts, union halves, flexible connectors, and other connection elements shall slip freely into place.
   4. Alter piping assembly to fit when proper fit is not obtained.

5. Install eccentric reducers or increasers with the top horizontal for pump suction piping.

3.04 BURIED PIPING

A. Bury piping with minimum three-foot cover without air traps, unless otherwise indicated on the Drawings.

B. Where two similar services run parallel to each other, piping for such services may be laid in the same trench. Lay piping with sufficient room for assembly and disassembly of joints, for thrust blocks, for other structures, and to meet separation requirements of public health authorities having jurisdiction.

C. Laying Piping:
   1. Lay piping in finished trenches free from water or debris. Begin at the lowest point with bell ends up slope.
   2. Place piping with top or bottom markings with markings in proper position.
   3. Lay piping on an unyielding foundation with uniform bearing under the full length of barrels.
   4. Where joints require external grouting, banding, or pointing, provide space under and immediately in front of the bell end of each section laid with sufficient shape and size for grouting, banding, or pointing of joints.
   5. At the end of each day's construction, plug open ends of piping temporarily to prevent entrance of debris or animals.

3.05 CLEANING

A. Piping Cleaning: Upon completion of installation, clean piping interior of foreign matter and debris. Perform special cleaning when required by the Contract Documents.

B. Cleaning Potable Water Piping: Flush and disinfect potable water piping.

C. Cleaning Chlorine Piping:
   1. Clean chlorine piping by pulling clean cloths saturated with trichloroethylene or other suitable chlorinated solvent through piping.
   2. Do not use hydrocarbons or alcohols which may react with chlorine.
   3. Use chlorinated solvents in accordance with manufacturer's safety recommendations to avoid serious physiological effects.
   4. Disassemble and clean valves and equipment that have oil residues before installation.
   5. Dry piping immediately before effecting final connections for service. Keep piping sealed to prevent moisture from entering chlorine piping. Drying procedure shall be as follows:
      a. Pass steam through piping from the high end until piping is thoroughly heated. While steaming, allow condensate and foreign matter to drain out.
      b. Stop steaming and drain pockets and low points.
      c. While piping is hot, blow dry air through piping until piping is dry. Use dry air with a dew point of minus 40 degrees F or below.
      d. Continue blowing dry air through piping until exhausted air has a dew point of minus 30 degrees F or below.
      e. Allow several hours for drying piping.

D. Cleaning Air Piping:
   1. Perform special cleaning of filtered air piping from the intake clean air plenums to the discharge points and high pressure air piping. Protect surfaces from contamination.
   2. Special cleaning shall include wire brushing, power tool cleaning, wiping down with lint free cloths, brooming, and vacuuming to remove rust, scale, weld spatter, dust, dirt, oil, and other matter deleterious to operation of the air system. Do not sandblast installed piping.
   3. To the greatest extent possible, clean piping immediately prior to final closure of piping systems.
      a. Enter piping, clean and wipe down surfaces, and vacuum out residue.
      b. Clean surfaces not accessible to this cleaning operation after installation within six hours preceding installation.
   4. Subsequent to cleaning, protect surfaces from contamination by dust, dirt, construction debris, and moisture, including atmospheric moisture.
      a. Whether or not pipe upstream has been cleaned, temporarily seal openings in partially completed work except when installation is actively in progress.
      b. When installation is actively in progress, seal openings at the end of each day's construction or when construction is temporarily stopped.
   5. Suspend cleaning and seal openings when inclement weather, including dust storms, is imminent.
   6. Use clean, dry air for testing the piping and other elements of the system.
   7. Prior to introduction of air to the system, blow piping clean. Blow with maximum discharge rate possible for minimum 4 hours, using new blowers or compressors and filters.
   8. Clean surfaces which become contaminated prior to acceptance.

3.06 PIPING SCHEDULE

A. Abbreviations:
   1. The following abbreviations used in the column of test method refer to the respective methods specified in Section 15956.

AM	Air method
GR	Gravity method
HH	High head method
LH	Low head method
SC	Special case

   2. Abbreviations to designate piping include the following:

CAP	Coagulant aid polymer
CI	Cast iron
CISP	Cast iron soil pipe
CL	Class, followed by the designation
CM	Cement mortar
CMP	Corrugated metal pipe
CMPA	Corrugated metal pipe arch
CPVC	Chlorinated polyvinyl chloride

CS	Carbon steel
DIP	Ductile iron piping
DWP	Dewatering Polymer
Ga	Gauge, preceded by the designation
GSP	Galvanized steel pipe
GE	Grooved end joint
HPC	High performance coating
NPS	Nominal pipe size, followed by the number in inches, pounds per square inch, or pounds per square inch, gauge.
PE	Polyethylene encasement
PVC	Polyvinyl chloride
RCP	Reinforced Concrete Pipe
Sch.	Schedule, followed by the designation
SS	Stainless steel
TW	Tape wrap

3. Abbreviations to designate pipe joint type include the following:

BW	Butt welded
B&SP	Bell and spigot pipe
FLG	Flanged
FW	Fusion welded
Mech. Restr.	Mechanically restrained
MJ	Mechanical joint
Push-on Restr.	Push-on restrained
SCRD	Screwed
SOCW	Socket welded
SW	Solvent weld

PIPING SCHEDULE

Process Abbrev.	Service	Nominal Diameter (inches)	Materials	Joints/ Fittings	Test Pressure/ Method	Lining	Coating	Comments
CDL	Chemical Drain	All	Sch. 80 CPVC	SW	100 psig/HH	None	HPC	
NPW	Non-Potable Water	All	Sch. 80 PVC	SW	100 psig/HH	None	HPC	
PW	Potable Water	All	Sch. 80 PVC	SW	100 psig/AM	None	HPC	
SBS	Sodium Bisulfite	All	Sch. 80 CPVC	SW	100 psig/HH	None	HPC	Aboveground to be insulated and heat traced
SHC	Sodium Hypochlorite	All	Sch. 80 CPVC	SW	100 psig/HH	None	HPC	
SPL	Sample Line	All	Sch. 80 PVC	SW	100 psig/HH	None	HPC	
V	Chemical Facility	All	Sch. 80 CPVC	SW	15 feet/GR	None	HPC	

Notes:

1. All exposed piping shall be painted and/or coated in accordance with Section 09960.

END OF SECTION

SECTION 15062

PREFORMED CHANNEL PIPE SUPPORT SYSTEM

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes: Preformed channel pipe support system consisting of preformed channels, fittings, straps, and fasteners engineered to support piping.

1.02 REFERENCES

A. American Institute of Steel Construction (AISC).

B. American Iron and Steel Institute (AISI).

C. American National Standard Institute/Manufacturer's Standardization Society (ANSI/MSS):
   1. SP-58 - Pipe Hangers and Supports - Materials, Design, and Manufacture.
   2. SP-69 - Pipe Hangers and Supports - Selection and Application.

1.03 SYSTEM DESCRIPTION

A. Design Responsibility:
   1. The manufacturer of the preformed channel pipe support system shall be considered the designer of the support system.
   2. Prepare design calculations utilizing the design criteria included in these Specifications.
   3. Prepare detailed Shop Drawings illustrating the layout of the support system and identifying the components of the support system.

B. Design Criteria:
   1. Include live, dead, and seismic loads associated with piping, valves, and appurtenances. Consider the content of the pipes in load calculations.
   2. Minimum Gauge Thickness: 12 gauge.
   3. Allowable Stress of Channels:
      a. Steel Channels: The lesser of 25,000 pounds per square inch, or 0.66 times yield stress of steel.
      b. Stainless Steel Channels: 0.66 times the yield stress of the stainless steel alloy.
   4. Maximum Deflection: 1/240 of span.
   5. Allowable Column Loads: As recommended by manufacturer in published instruction for column's unsupported height and "K" value for calculating effective column length of not less than 1.0.
   6. Future Loads:
      a. Support systems indicated on the Drawings may include spaces intended to accommodate future pipes.

b. Unless otherwise indicated on the Drawings, assume such spaces are occupied by six-inch diameter ductile iron pipes. Only the number of pipes that would physically fit into the space need be considered.
c. Include the weight of the pipe contents in determining future loads. Assume pipe contents are water.

7. Seismic Design Criteria: As specified in Section 01612 as specified for mechanical equipment.
8. Spacing of Supports: As required to comply with design requirements but not more than 5 feet.

C. Supports below the Top of Walls of Water Bearing Structures: Use Type 316 stainless steel for support system components.
1. Supports in Other Locations: Use hot-dipped galvanized components unless other materials are specifically indicated on the Drawings.

1.04 SUBMITTALS

A. Shop Drawings: Include layout of support system including pipe loads, selected channel size, fittings, and appurtenances.

B. Structural Design Calculations.

1.05 QUALITY ASSURANCE

A. Design Preformed Channel Pipe Support System for Loads in Accordance with Applicable Provisions of:
1. AISC Manual of Steel Construction.
2. AISI Cold-Formed Steel Design Manual.

B. Product Standards:
1. Pipe Support Components: Conform to MSS SP-69.
2. Pipe Support Materials: Conform to MSS SP-58.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Materials:
1. Type 316 stainless steel or FRP when indicated.
2. Galvanized, painted, and electroplated materials are not acceptable.

B. Fabricate preformed channel pipe support system using, as a minimum, parts specified below and meeting the requirements specified under Design Criteria.
1. Manufacturers: One of the following or equal:
a. Unistrut, Series P1000 or P1001; P5500 or P5501, as indicated on the Drawings.
b. Allied Support Systems, Power Strut, Figure PS-200 or PS-200 2TS; PS-150 or PS-150 2TS.
c. B-Line Systems, Inc., Channel Type B22 or B22A; B12 or B12A.

2.02 ACCESSORIES

A. Preformed Channel Concrete Inserts: Minimum 12 inches long.
   1. Manufacturers: One of the following or equal:
      a. Unistrut, Series P-3200.
      b. Allied Support Systems, Figure 282.
      c. B-Line Systems, Series B32I.

B. 90 Degree Angle Fittings:
   1. Manufacturers: One of the following or equal:
      a. Unistrut, P1026.
      b. Allied Support Systems, Power Strut, P603.

C. Pipe Straps:
   1. For Pipes 8 Inches in Diameter and Smaller: Use 2-piece universal strap with slotted hex head screw and nut.
      a. Manufacturers: One of the following or equal:
         1) Unistrut, Series P1109 through P1126.
         2) Allied Support Systems, PS1100.
         3) B-Line Systems, Inc., Series B2000.
   2. For Pipes Greater than 8 Inches in Diameter: Unless different material is otherwise indicated on the Drawings use one piece one inch wide by 1/8 inch thick steel strap, hot-dip galvanized after fabrication.
   3. For Stainless Steel Pipes: Use type of strap required for the pipe sizes specified above, but use Type 316 stainless steel materials.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install preformed channel concrete inserts for vertical support, quantity based on manufacturer's structural design calculations.

B. Fasten preformed channel pipe supports to existing walls using Z-fittings and concrete anchors as indicated on the Drawings.

C. Fasten preformed channel pipe supports to preformed channel concrete inserts embedded in ceiling using U-shaped fittings.

D. Suspend threaded rods from concrete inserts embedded in ceiling. Support preformed channel pipe supports with threaded rods.

E. Prevent contact between pipes and support components of dissimilar metals. Utilize rubber coated, plastic coated, or vinyl coated components, stainless steel components, or wrap pipe with PVC or polyethylene tape.

F. Install support as near as possible to concentrated loads.

G. Install support within two feet of horizontal and vertical changes in pipe alignment.

H. Adjust supports or install shims to obtain specified slope or elevation.

END OF SECTION

SECTION 15075

MECHANICAL IDENTIFICATION

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Mechanical Identification including the following:
   1. Equipment nameplates.
   2. Pipe identification by color and legend.
   3. Special items.
   4. Underground warning tape.
   5. Identification of equipment and components of systems with paint, brands, tags, and signboards.

1.02 REFERENCES

A. American National Standards Institute (ANSI):
   1. A13.1 - Scheme for the Identification of Piping Systems.

1.03 SUBMITTALS

A. Submit in accordance with Section 01330.

B. Submit following:
   1. Product data.
   2. Samples.
   3. Manufacturer's installation instructions.
   4. Submit following as specified in Section 01770:
      a. Operation and Maintenance Data.
      b. Warranty.

1.04 QUALITY ASSURANCE

A. Regulatory requirements: Comply with all applicable federal, state, and local requirements.

PART 2 PRODUCTS

2.01 EQUIPMENT NAMEPLATES

A. Material and fabrication:
   1. Stainless steel sheet engraved or stamped with text, holes drilled, or punch for fasteners.

B. Fasteners:
   1. Number 4 or larger oval head stainless steel screws or drive pins.

C. Text:
   1. Manufacturers name, equipment model number and serial number, identification tag number, and when appropriate, drive speed, motor horsepower with rated capacity, pump rated total dynamic head and impeller size.

2.02 PIPE IDENTIFICATION

A. Manufacturers:
   1. One of the following or equal:
      a. Seton, Opti Code Pipe Markers.
      b. Lab Safety Supply.
      c. Marking Services Inc.

B. Materials:
   1. Pipe markers: Self-adhesive vinyl, suitable for outdoor application from -40 degrees to 180 degrees Fahrenheit; meet ANSI A13.1 requirements.
      a. Lettering:

Nominal Pipe Diameter	Lettering Size
Less than 1.5	1/2 inch
1.5 inches to 2 inches	3/4 inch
2.5 inches to 6 inches	1-1/4 inches
8 inches to 10 inches	2-1/2 inches
Over 10 inches	3-1/2 inches

      b. Marker colors:

Service	Lettering	Background
Flammables, chemicals, toxics	Black	Yellow
Water, nontoxic solutions or low hazard liquids	White	Green
Nonflammable or nontoxic gases	White	Blue
Fire quenching fluids (foam, fire water, CO_2 Halon)	White	Red

   2. Coating: As specified in Section 09960.
   3. Pipe identification tags: Aluminum or stainless steel with stamped-in 1/4 inch high identifying lettering.
   4. Pipe identification tag chains: Aluminum or stainless steel.
   5. Snap-on markers: Markers with 3/4 inch high letters for 3/4 to 4 inch pipe or covering, or 5 inch high letters for 5 inch or larger pipe or cover, as manufactured by one of following:
      a. Brady Bradysnap-On B-915.
      b. Seton Setmark.

2.03 SPECIAL ITEMS

A. In addition, special coating of following items will be required:

Item	Color
Valve handwheels and levers	Red
Hoist hooks and blocks	Yellow and black stripes
Steel guard posts	In accordance with standard details

B. Paint minimum 2 inches high numbers on or adjacent to accessible valves, pumps, flowmeters, and other items of equipment which are identified on Drawings or in Specifications by number.

2.04 UNDERGROUND WARNING TAPE

A. Manufacturer:
   1. One of the following or equal:
      a. Seton Name Plate Company, Branford, CT.

B. Material:
   1. Metallic detection tape; minimum 4 mil thick by 6 inches wide polyethylene film with wording, "Caution" with name of service followed by words, "Line Buried Below" repeated continuously along tape length, with alternate metallic and color strips. Colors as follows:
      a. Water: Blue.
      b. Telephone: Orange.
      c. Sewer: Green.
      d. Gas and other services: Yellow.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify satisfactory conditions of substrate for applying identification.

B. Verify that conditions are satisfactory for installation and application of products as specified in Section 01600.

3.02 PREPARATION

A. Prepare and coat surfaces as specified in Section 09960.

B. Prepare surface in accordance with product manufacturer's instructions.

3.03 PIPING IDENTIFICATION

A. Identify exposed piping, valves, and accessories in accessible chases with lettering or tags designating service of each piping system with flow directional arrows and color code.

B. Color code:
   1. Paint piping scheduled to be color coded completely with specified colors.
   2. Paint segments of pipe specified to be unpainted with specified coding color long enough to accommodate required lettering and arrows.

C. Lettering and flow direction arrows:
   1. Stencil lettering on painted bands or use snap-on markers on pipe to identify pipe. When stenciling, stencil 3/4 inch high letters on 3/4 through 4-inch pipe or coverings, or 5-inch high letters on 5-inch and larger pipe or coverings.
   2. Provide lettering and flow direction arrows near equipment served, adjacent to valves, both sides of walls and floors where pipe passes through, at each branch or tee, and at intervals of not more than 50 feet in straight runs of pipe.

D. Where scheduled, space 6-inch wide bands along stainless steel pipe at 10-foot intervals and other pipe at 5-foot intervals.

E. Label chemical tank fill pipelines at locations which are visible from chemical fill stations.

F. Metal tags:
   1. Where outside diameter of pipe or pipe covering is 5/8 inch or smaller, provide metal pipe identification tags instead of lettering.
   2. Fasten pipe identification tags to pipe with chain.
   3. Where tags are used, color code pipe as scheduled.

G. Underground warning tape:
   1. Place warning tape in pipe trench, 12 inches above the pipe.

3.04 APPLICATION

A. Identify piping with legend markers, directional arrow markers, and number markers; use self adhesive arrow roll tape to secure ends of piping markers and indicate flow direction.

B. Provide legend markers, directional arrow markers and number markers where piping passes through walls or floors, at piping intersections and at maximum 15 foot spacing on piping runs.

C. Provide piping marker letters and colors as scheduled.

D. Place markers on piping so they are visible from operator's position in walkway or working platform near piping. Locate markers along horizontal centerline of pipe, unless better visibility is achieved elsewhere.

3.05 PIPING COLOR CODE AND MARKER SCHEDULE

Service Fluid	Pipe Color	Band Color	Color of Letters	Marker Legend[1]
Sodium Hypochlorite	Yellow	None	Black	SHC
Sodium Bisulfite	Yellow	Orange	Black	SBS
(1) Verify with OWNER the preferred colors listed in this table.				

END OF SECTION

SECTION 15111

BALL VALVES

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes: Plastic body ball valves.

1.02 REFERENCES

A. American National Standards Institute (ANSI):
   1. B16.5 - Pipe Flanges and Flanged Fittings.

B. American Society for Testing and Materials (ASTM):
   1. A 351 - Specification for Castings, Austenitic, Austenitic-Ferritic (Duplex), for Pressure-Containing Parts.

C. American Water Works Association (AWWA):
   1. C 507 - Standard for Ball Valves 6 Inch through 48 Inch.

1.03 SYSTEM DESCRIPTION

A. General: Unless otherwise indicated on the Drawings use:
   1. Metal body ball valves on metallic pipelines.
   2. Plastic body ball valves on plastic pipelines.

B. Do not use metal body ball valves in sodium hypochlorite systems.

1.04 SUBMITTALS

A. Product Data: Submit manufacturer's catalog data describing Design and technical features for products specified.

B. Certifications: Metal Body Ball Valves: Submit affidavit of compliance with AWWA C 507.

PART 2 PRODUCTS

2.01 PLASTIC BODY BALL VALVES

A. Manufacturers: One of the following or equal:
   1. Asahi America.
   2. Chemtrol Division, NIBCO, Inc.
   3. Hayward Industrial Products.
   4. Spears Manufacturing Co.

B. General:
   1. Type: Non lubricated and capable of sealing in either flow direction.
   2. End Connections: True union.
   3. Operator Handle: Lever.

C. Materials:
   1. Body: Polyvinyl chloride (PVC) or chlorinated polyvinyl chloride (CPVC) to match piping material.
   2. Ball: Polyvinyl chloride (PVC) or chlorinated polyvinyl chloride (CPVC) to match body material.
   3. Seats: TFE (Teflon).
   4. O-Rings: FPM (Viton) or EPDM in accordance with the table below.

	FPM (Viton)	**EPDM**
Chlorine Solution	Yes	No
Citric Acid	Yes	Yes
Ferric Chloride	Yes	Yes
Ferrous Chloride	Yes	Yes
Hydrofluosilicic Acid	Yes	Yes
Polymer	Yes	No
Sodium Hydroxide	No	Yes
Sodium Hypochlorite	Yes	No
Aluminum Sulfate	Yes	Yes
Sodium Bisulfite	Yes	Yes
Sewage	Yes	--
Water	Yes	Yes

PART 3 EXECUTION

3.01 INSTALLATION

A. General: Install each type of valve in accordance with manufacturers' printed instructions.

B. Off Gassing Fluids: If PVC or CPVC ball valves are called for on the Drawings in sodium hypochlorite service, or other off gassing fluid, drill a 0.125-inch hole in the downstream side of the ball; remove burrs from hole. Provide an engraved plastic tag permanently attached to the valve stem stating "One side of ball drilled for sodium hypochlorite or off gassing service."

END OF SECTION

SECTION 15117

SPECIALTY VALVES

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Plastic Body Diaphragm Valves.
   2. Vacuum Relief Valves.

1.02 REFERENCES

A. American Water Works Association (AWWA):
   1. C 511 - Reduced Pressure Principle Backflow Prevention Assembly.

B. ASTM International (ASTM):
   1. A 126 - Specification for Gray Iron Casting for Valves, Flanges, and Pipe Fittings.
   2. A 276 - Specification for Stainless Steel and Heat-Resisting Steel Bars and Shapes.
   3. B 584 - Specification for Copper Alloy Sand Castings for General Application.
   4. D 2000 - Classification System for Rubber Products in Automotive Applications.

C. National Electrical Manufacturers Association (NEMA).

1.03 SUBMITTALS

A. Submittals Prior to Installation: Product Data: Submit detailed technical information relating to each type of valve including description of component parts, materials of construction, performance, dimensions, and weights.

B. Operation and Maintenance Data: Furnish bound sets of installation, operation, and maintenance instructions for each type of valve as specified in Section 01782. Include information on valve operators in operation and maintenance instruction manual.

1.04 QUALITY ASSURANCE

A. Manufacturer Qualifications: Manufactured by manufacturers whose valves have had successful operational experience in comparable service.

1.05 DELIVERY STORAGE AND HANDLING

A. Protect valves from damage during handling and installation.

PART 2 PRODUCTS

2.01 PLASTIC BODY DIAPHRAGM VALVES

A. Type of Service: Use plastic body diaphragm valves in the following services:
   1. Sodium hypochlorite.
   2. Sodium chlorite.
   3. Chlorine gas.

B. Manufacturers: One of the following or equal:
   1. Asahi America.
   2. Spears Manufacturing Co.
   3. Chemtrol.

C. Materials:
   1. Body: PVC or CPVC, as required to match system piping material with reinforcing ribs at body and end connections.
   2. Diaphragm:
      a. Unless otherwise specified below, provide 2 diaphragm layers - Teflon diaphragm with EPDM backing or other material suitable for the intended use.
      b. For Sodium Hypochlorite Service: 3 diaphragm layers, Teflon (PTFE), PVDF, and ethylene-propylenediene (EPDM) or Viton backing cushion.
   3. Bonnet: Reinforced polypropylene with cast iron or silicon bronze drive nut, double lead acme stem threads, acrylic protective cap and visual position indicator.
      a. Adjustable Travel Stop: Stainless steel.
      b. Compressor: Cast iron.
   4. Handwheel: Polypropylene.
   5. Sleeve: Cast iron.
   6. Stem: Stainless steel.
   7. Bolt, Nut and Washer: Stainless steel.
   8. Thrust Bearing: Teflon disc or carbon steel.
   9. End Connector: PVC or CPVC.
   10. O-Rings: Viton.
   11. Position Indicator: Carbon steel.

D. Valve Design:
   1. End Connections: True union both ends; solvent welded to pipe.
   2. Operator Handle: Handwheel, with position indicator and adjustable travel stop to prevent overtightening. Provide acrylic stem cap.
   3. Diaphragm Valves: Weir type.
   4. Pressure: 150 psig at 70 degrees F.

2.02 VACUUM RELIEF VALVES

A. Manufacturers: The following or equal:
   1. Plast-o-matic Valves, Inc., CKM Series.

B. Design:
   1. Vacuum valves: To be normally closed, self closing, diaphragm type with National Pipe Thread (NPT) inlet and outlet connections.

2. Minimum opening pressure: Diaphragm opens at 1.5 psi or less.

C. Materials:
   1. Body: PVC.
   2. Diaphragm: Viton.
   3. Seals: Viton.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's published instructions.

B. Backflow Preventers:
   1. Install with a minimum clearance of 12 inches and with maximum clearance of 30 inches between the relief port and the floor or finished grade.
   2. Install with sufficient side clearance for access for testing and maintenance.

END OF SECTION

SECTION 15120

PIPING SPECIALTIES

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes: Piping specialties including:
   1. Pressure gauges.
   2. Rotameter type flowmeter.
   3. Flange-mounted magnetic type level indicator.

1.02 REFERENCES

A. American National Standards Institute (ANSI).

B. American Water Works Association (AWWA):
   1. AWWA C153/A21.53 - Ductile-Iron Compact Fittings.
   2. AWWA C111/A21.11 - Rubber Gasket Joints for Ductile-Iron and Gray-Iron Pressure Pipe and Fittings.
   3. AWWA C110/A21.10 - Ductile-Iron and Gray-Iron Fittings.
   4. AWWA C213 - Fusion-Bonded Epoxy Coatings and Linings for Steel Water Pipelines.
   5. AWWA C151/A21.51 - Ductile-Iron Pipe, Centrifugally Cast.

C. ASTM International (ASTM):
   1. ASTM A 148 - Specification for Steel Castings, High-Strength, for Structural Purposes.
   2. ASTM A 536 - Specification for Ductile Iron Castings.

D. Society of Automotive Engineers (SAE).

1.03 SUBMITTALS

A. Shop drawings detailing dimensions and materials.

B. Manufacturer's published installation instructions.

C. Operation and maintenance manuals as specified in Section 01782.

D. Provide with the submittal a copy of this Specification, marked up to indicate either compliance with or exception to each Section of Specification. The exceptions shall be put in a complete list separate from the copy of the Specification. This list can be inserted in with the submittal in front of the marked up copy of the Specification.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Expansion Joints and Vibration Control Joints:

1. Protect joint bellows and sliding surfaces against damage during packing, shipping and installation, and also during pressure test.
2. Lock expansion joints against movement until pressure tests are completed.
3. Replace damaged expansion joints with new and undamaged expansion joints.

PART 2 PRODUCTS

2.01 PRESSURE GAUGES

A. Design:
1. Provide dual-range (psi/ft H_2O), liquid filled gauges with ranges as indicated in the Drawings.
2. Size: As follows, unless otherwise indicated on the Drawings or specified:
   a. For 1-Inch Pipe and Larger: 4-1/2 inch diameter.
   b. For Smaller than 1-Inch Pipe: 2-1/2 inch diameter.
3. Provide gauges with Type 316 stainless steel, wetted parts phenolic cases with threaded ring, except for panel mounting, in which case provide gauge with front flanged aluminum case with threaded ring. Apply black epoxy coating to cases.
4. Provide case fitted with a rupture disc which shall relieve out the back of the case.
5. Window: Shatterproof glass or high temperature acrylic.
6. Provide gauges with Type 316 stainless steel socket and bellows or bourdon tube, depending on pressure range.
   a. Where the maximum pressure is less than or equal to 15 pounds per square inch, the gauge shall use bellows as the measuring element.
   b. Where the maximum pressure is greater than 15 pounds per square inch, the measuring element shall be a bourdon tube.
7. Socket Tips:
   a. Socket Tips for Bellows and Bourdon Tube: Type 316 Stainless steel.
   b. Size: 1/2 inch for 4-1/2 inch diameter gauges, 1/4 inch for 2-1/2 inch diameter gauges.
8. Mount gauges on diaphragm seals where indicated on the Drawings.
   a. Provide diaphragm seals with Type 316 stainless steel top housing, bottom housing and bolt assemblies, except as follows:
      1) Sodium hypochlorite and ferric chloride service: Provide Hastelloy C diaphragm seal bottom housing.
   b. Fit bottom housing with a 1/4 inch flushing connection with Type 316 stainless steel nipple and shutoff cock.
      1) Sodium hypochlorite and ferric chloride service: Provide PVC shutoff cock.
   c. Diaphragm Seal: Removable.
      1) For pressure less than or equal to 15 pounds per square inch, provide viton diaphragm seal.
      2) For pressures greater than 15 pounds per square inch, provide Type 316 stainless steel diaphragm seal.
      3) For sodium hypochlorite and ferric chloride applications, provide Viton diaphragms seals.
   d. Fit diaphragm seal gauge assembly with a snubber.

1) Snubber shall have porous metal disc sized to dampen pressure fluctuations in the filled system.
2) Snubber: Stainless steel.
3) Snubber filter disc shall be sized to prevent the gauge from pulsating.
4) Provide diaphragm seal gauge assemblies filled with silicon.

9. Pressure gauges, except gauges with diaphragm seals, shall have pulsation dampeners installed between the gauge and the shut-off valve.
   a. Pulsation Dampeners: Stainless steel.

B. Manufacturers:
   1. Pressure Gauges: One of the following or equal:
      a. Dresser Industries, Inc., Ashcroft Figure Number 1379.
      b. U.S. Gauge Division of Ametek, Inc., Solfrunt Gauges, Figure Number 1931T.
   2. Diaphragm Seal: One of the following or equal:
      a. For pressure less than or equal to 15 pounds per square inch:
         1) Ashcroft, Type 301.
         2) Mansfield and Green, Type LG.
      b. For pressures greater than 15 pounds per square inch:
         1) Ashcroft, Type 101.
         2) Mansfield and Green, Type RG.
   3. Snubber: One of the following or equal:
      a. Ashcroft, Type Number 1112S.
      b. Chemiquip.
   4. Pulsation Dampeners: One of the following or equal:
      a. Dresser Industries, Inc., Ashcroft, Figure Number 1106S.
      b. Operation and Maintenance Specialties, Charlotte, N.C., Ray Pressure Snubbers.

2.02 ROTAMETER TYPE FLOWMETER

A. Manufacturers: One of the following or equal:
   1. Brooks Instrument Company.
   2. Bailey-Fischer and Porter.
   3. King Instrument Company.

B. Variable Area Flowmeters: Straight through flow type.

C. Rotameter: Full view type with Buna-N O-ring seals suitable for pipeline or panel mounting; and size, temperature rating, capacities, and maximum allowable pressure drops (losses) across meter that are compatible with process requirements.

D. Wetted Parts and Float: Made of suitable material to handle service conditions and process flow rates.

E. Metering Tube: Borosilicate glass, unless precluded by process conditions and fluids requirements.

F. Fittings: Stainless steel.

G. Float Stops: Teflon.

H. Detachable Flow Scale: Approximately 10 inches long or nearest manufacturer's standard length; with safety glass shielding in front of rotameter.

I. Rotameter Calibration:
   1. Accuracy: Within 1 percent of full scale from 100 to 10 percent of reading.
   2. Rangeability: Minimum 10:1.

J. Pipe Connections: 1/2 inch NPT, or as indicated on the Drawings.

2.03 FLANGE-MOUNTED MAGNETIC TYPE LEVEL INDICATOR

A. Manufacturers: The following or equal:
   1. Gems Sensors, Sure Site Type BP.

B. Magnetic Level Indicators:
   1. PVC housing and PVC float.
   2. 2-inch flanged side mount connections.
   3. Pipe caps top and bottom.
   4. Colored magnetic flag indicators.
   5. Rated 40 pounds per square inch/140 degrees Fahrenheit.
   6. Alum Tanks: Indicating height of 9.5 feet.
   7. Polymer Tanks: Indicating height of 7.5 feet.

PART 3 EXECUTION

3.01 INSTALLATION

A. Pressure Gauges:
   1. Install pressure and compound gauges as indicated on the Drawings and as specified.
   2. Install gauges as specified, and as recommended by the manufacturer in published instructions.

3.02 FIELD QUALITY CONTROL

A. Testing: Field test gauges with a calibrated test gauge, in the presence of ENGINEER.

END OF SECTION

SECTION 15265

PLASTIC PIPING AND TUBING

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes: Plastic pipe, tubing, and fittings.

1.02 REFERENCES

A. American National Standards Institute (ANSI):
   1. ANSI B 16.12 - Cast Iron Threaded Screwed Drainage Fittings.

B. American Society for Testing and Materials (ASTM):
   1. D 1784 - Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds.
   2. D 1785 - Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80 and 120.
   3. D 1869 – Specification for Rubber Rings for Asbestos-Cement Pipe.
   4. D 2466 - Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40.
   5. D 2467 - Specification for Socket-Type Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.
   6. D 2564 - Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems.
   7. D 2855 - Standard Practice for Making Solvent-Cemented Joints with Poly (Vinyl Chloride)(PVC) Pipe and Fittings.
   8. D 3034 – Specification for Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
   9. F 439 - Specification for Socket-Type Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80.
   10. F 441 - Specification for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe, Schedules 40 and 80.
   11. F 477 – Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.
   12. F 493 - Specification for Solvent Cements for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe and Fittings.
   13. F 645 - Guide for Selection, Design and Installation of Thermoplastic Water Pressure Piping Systems.
   14. F 679 – Specification for Poly (Vinyl Chloride) (PVC) Large-Diameter Plastic Gravity Sewer Pipe and Fittings.

C. American Water Works Association (AWWA):
   1. C 900 - Polyvinyl/Chloride (PVC) Pressure Pipe, 4 Inches Through 12 Inches, for Water Distribution.

D. Code of Federal Regulations:
   1. Title 49 - Transportation.

E. United States Department of Transportation:
   1. Materials Transportation Bureau.

1.03 ABBREVIATIONS

A. CPVC: Chlorinated Polyvinyl Chloride.

B. ID: Inside Diameter of piping or tubing.

C. NPS: Nominal pipe size followed by the size designation.

D. NS: Nominal size of piping or tubing.

E. PP: Polypropylene.

F. PVC: Polyvinyl Chloride.

G. SDR: Standard Dimension Ratio; the Outside Diameter, divided by the pipe wall thickener.

1.04 SUBMITTALS

A. Product Data: Describe materials, pipe, fittings and solvent cement.

B. Manufacturer's Published Installation Instructions.

C. Certificates:
   1. Submit manufacturer's certificate attesting that plastic pipe, tubing, and fitting types meet specified requirements.
      a. PVC gravity sewer piping: Requirements of ASTM D 3034 or ASTM F 679, as applicable.
   2. Manufacturer's certification of date of manufacture of plastic pipe and tubing for each lot delivered.
   3. Copies of solvent cement manufacturer's report and certification in accordance with ASTM D 2564 for PVC piping, and ASTM F 493 for CPVC piping.

1.05 QUALITY ASSURANCE

A. Plastic Pipe in Potable Water Applications: Provide pipe and tubing bearing NSF seal.

B. Mark plastic pipe with nominal size, type, class, schedule or pressure rating, manufacturer and all markings required by applicable ASTM and AWWA standards.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Protect piping materials from sunlight, scoring and distortion.

B. Do not allow surface temperatures on pipe and fittings to exceed 120 degrees Fahrenheit.

PART 2 PRODUCTS

2.01 MATERIALS

A. Extruding and Molding Material: Virgin material containing no scrap, regrind, or rework material except where permitted in the referenced standards.

B. Fittings: Same material as the pipe and of equal or greater pressure rating, except that fittings used in drain, waste and vent piping systems need not be pressure rated.

C. Unions 2 1/2 Inches and Smaller: Socket end screwed unions. Make unions 3 inches and larger of socket flanges with 1/8 inch full-face soft Viton gasket.

2.02 CPVC PIPING

A. Materials:
   1. CPVC Pipe: Schedule 80 unless, otherwise indicated on the Drawings, in accordance with ASTM F 441 and Appendix, CPVC 4120.
      a. Pipe: Extruded from Type IV, Grade 1, Class 23447 material in accordance with ASTM D 1784.
      b. Manufacturers: One of the following or equal:
         1) Charlotte Pipe and Foundry Company.
         2) Eslon Thermoplastics, Inc.
         3) Harvel Plastics, Inc.
   2. Fittings: Conform to ASTM F 438 or ASTM F 439 for pressure fittings, as appropriate to the service and pressure requirement.
      a. Fittings: Supplied by the pipe manufacturer.
      b. Manufacturers: One of the following or equal:
         1) Colonial Engineering.
         2) Eslon Thermoplastics, Inc.
         3) Chemtrol.
         4) Spears Manufacturing Company.
   3. Solvent Cement:
      a. In accordance with ASTM F 493.
      b. For CPVC pipe in sodium hypochlorite service, utilize IPS Corp Type 724 cement or another cement certified by the manufacturer for high strength hypochlorite service.

2.03 SOURCE QUALITY CONTROL

A. PVC Piping, Schedule Type: Mark pipe and fittings in accordance with ASTM D 1785.

B. CPVC Piping: Mark pipe and fittings in accordance with ASTM F 441.

C. CPVC Piping, Class Type:
   1. Test pipe to withstand, without failure, 600 pounds per square inch, gauge, hydrostatic pressure for a minimum of 5 seconds.
   2. Test integral bell with the pipe.

D. PVC Gravity Sewer Piping:
   1. Mark pipe and fittings in accordance with ASTM D 3034. Also mark the production control code on pipe and fittings.

PART 3 EXECUTION

3.01 INSTALLATION

A. General:
   1. Where not otherwise specified, install piping in accordance with ASTM F 645, or manufacturer's published instructions for installation of piping, as applicable to the particular type of piping.
   2. Provide molded transition fittings for transitions from plastic to metal or IPS pipe. Do not thread plastic pipe.
   3. Locate unions where indicated on the Drawings, and elsewhere where required for adequate access and assembly of the piping system.
   4. Provide serrated nipples for transition from plastic pipe to rubber hose.

B. Installation of PVC Piping, Schedule Type:
   1. Solvent weld joints in accordance with ASTM D 2855.
      a. For PVC pipe in sodium hypochlorite service use IPS Corp. Type 724 cement in accordance with manufacturer's instructions.
   2. Install piping in accordance with Appendix of AWWA C 900 complemented by manufacturer's published instructions.

C. Installation of CPVC Piping, Schedule Type:
   1. Clean dirt and moisture from pipe and fittings.
   2. Bevel pipe ends in accordance with manufacturer's instructions with chamfering tool or file. Remove burrs.
   3. Use solvent cement and primer formulated for CPVC.
      a. For CPVC pipe in sodium hypochlorite service use IPS Corp. Type 724 cement in accordance with manufacturer's instructions.
   4. Use primer on pressure and non-pressure joints.
   5. Do not solvent weld joints when ambient temperatures are below 40 degrees Fahrenheit or above 90 degrees Fahrenheit unless solvent cements specially formulated for these conditions are utilized.

D. Installation of Polyethylene (PE) Tubing and Fittings:
   1. Install small bore PE tubing in accordance with manufacturer's printed instructions, in neat straight lines, supported at close enough intervals to avoid sagging, and in continuous runs wherever possible.
   2. Bundle tubing in groups of parallel tubes within protective sheath.
   3. Tubes within protective sheath may be color coded, but protect tubing other than black outside the sheath by wrapping with black plastic electrician's tape.
   4. Grade tubing connected to meters in one direction.

E. Installation of PVC Piping, Class Type:
   1. Install piping in accordance with the Appendix of AWWA C 900 complemented with manufacturer's published instructions.

F. Installation of PVC Gravity Sewer Piping:
   1. Install piping in accordance with manufacturer's published instructions, as modified and complemented herein.
   2. Install pipe and fittings not later than 4 months after their manufacture.
   3. Provide for contraction and expansion at joints with a gasket ring.
   4. Provide plugs or caps for stubs and branch pipes left unconnected to laterals.
   5. Lubricate and assemble joints in accordance with the pipe manufacturer's published instructions.
   6. Make connections to manholes with a manhole gasket that prevents infiltration and exfiltration through the penetrations.
      a. Provide opening for connection large enough to allow subsequent grouting around the manhole gasket.
      b. Grout around the manhole gasket and seal the opening.

3.02 FIELD QUALITY CONTROL

A. Leakage Test for PVC Piping:
   1. Polyvinyl-chloride (PVC) Piping, Class Type: Subject to visible leaks test and to pressure test with maximum leakage allowance, as specified in Section 15956.
   2. Pressure Test with Maximum Leakage Allowance: Perform test after backfilling.
      a. Pressure: 125 pounds per square inch, gauge.
      b. Maximum leakage allowance as follows, wherein the value for leakage is in gallons per 100 joints per hour:

NPS, Inches	1-1/2	2	2-1/2	3	4	6	8	10	12
Leakage	0.41	0.52	0.63	0.76	0.98	1.45	1.88	2.35	2.80

B. Mandrel Tests for PVC Gravity Sewer and HDPE Piping:
   1. Perform Initial Mandrel Test:
      a. After cleaning and completion of other tests.
      b. After placement and compaction of backfill.
      c. Before construction of pavement or surfacing.
      d. Not sooner than 30 days after pipe installation.
      e. Not later than 60 days after installation.
   2. Perform Final Verification Mandrel Test:
      a. Not sooner than 30 days before the end of the warranty period.
      b. Not later than 10 days before the end of the warranty period.
      c. Consider the final verification mandrel test a warranty service, and include the costs related to final verification mandrel test in the Contract Price.
   3. Utilize a 9 rod mandrel with minimum length equal to NPS and diameter as follows:

Nominal Pipe Size (NPS)	Mandrel Diameter, inches
6	5.50
8	7.37
10	9.21
12	10.96
15	13.56

4. Test Procedure: Pull the mandrel through the line under test by one person, by hand, with reasonable effort, without the aid of mechanical equipment.
5. Failing Test: Where the mandrel test is not successful, remove and replace the section of piping with the obstruction, and test the piping again, including visible leaks test, pressure test with maximum leakage allowance, mandrel tests, and other specified tests.
   a. Correction of excessive deflection or obstructions by methods other than removal of the affected piping and replacement of the removed piping with new piping will not be accepted.

END OF SECTION

SECTION 15430

EMERGENCY EYEWASH/SHOWER UNITS

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes: Safety equipment:
   1. Emergency shower and eyewash.

1.02 REFERENCES

A. As applicable, equipment of this Section shall comply with requirements of public agencies of the state where the project is located including OSHA, Underwriters Laboratories, NFPA, and ASME.

B. American National Standards Institute (ANSI):
   1. Z358.1 - Emergency Eyewash and Shower Equipment.
   2. Z535.1 - Safety Color Code.

C. NIOSH Schedule 13F.

1.03 SUBMITTALS

A. Submit as specified in Section 15050.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Packing and Shipping: Deliver to the job site in manufacturer's original containers.

B. Delivery: After wet operations.

C. Storage and Protection: Store materials in original, unopened containers in compliance with manufacturer's printed instructions.

D. Keep materials dry until ready for use. Keep packages of material off the ground, under cover, and away from damp surfaces.

E. Protect finished surfaces from soiling and damage during handling and installation. Keep covered with a protective covering.

PART 2 PRODUCTS

2.01 EMERGENCY SHOWER AND EYEWASH

A. Manufacturers: One of the following or equal:
   1. HAWS, No. 8300.157.
   2. Guardian Equipment No. G1943, HFC - SSH.

B. Design Features:
   1. Fixture supplied with stanchion and floor flange with interconnecting piping.
   2. Showerhead deluge type with pull-rod operator on stay-open brass ball valve.
   3. 1-1/4-inch galvanized steel pipe with 1-1/4-inch IPS connection.
   4. Stainless steel showerhead.
   5. Flow control 30 gallons per minute brass assembly.
   6. Eyewash stainless steel receptor with two-spray type assembly. Provide with float-off dust covers. 5 gallons per minute minimum flow. Activated by stay-open valve with stainless steel push-flag and/or foot treadle.
   7. Provided with scald protection bleed valve when located outdoors in an unconditioned space.
   8. Provide flow switch with 1-1/4-inch IPS connections, 120 V 5 amp rating and single pole double throw switch. Flow switch to activate at 3-gpm flow rate.
   9. Provide ANSI compliant identification sign and markings.
   10. Meet or exceed all requirements of ANSI Z358.1.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install products in accordance with manufacturers' recommendations.

B. Emergency shower/eyewash station and piping shall be insulated when located outdoors.

C. Provide isolation valve for water supply to each emergency eyewash/shower unit installed.

3.02 PROTECTION

A. Repair or replace defective equipment with new.

END OF SECTION

SECTION 15956

PIPING SYSTEMS TESTING

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes: Test requirements for piping systems.

1.02 REFERENCES

A. International Plumbing Code (IPC).

B. National Fuel Gas Code: ANSI Z 223.1 or NFPA 54.

C. American National Standards Institute/American Society of Mechanical Engineers (ANSI/ASME):
   1. B31.8 - Gas Transmission and Distribution Piping Systems.
   2. B31.1 - Power Piping.
   3. B31.3 - Process Piping.

D. International Mechanical Code (IMC).

1.03 TESTING REQUIREMENTS

A. General Requirements:
   1. Testing requirements are stipulated in Laws and Regulations; are included in the Piping Schedule in Section 15052; are specified in the Specifications covering the various types of piping; and are specified herein.
   2. Requirements in Laws and Regulations supersede other requirements of Contract Documents, except where requirements of Contract Documents are more stringent, including higher test pressures, longer test times, and lower leakage allowances.
   3. Test plumbing piping in accordance with Laws and Regulations, the International Plumbing Code, and UL requirements.
   4. When testing with water, the specified test pressure is considered to be the pressure at the highest point of the piping section under test. Lower test pressure as necessary to prevent testing the lowest point above a safe test pressure.

B. Furnish necessary personnel, materials, and equipment, including bulkheads, restraints, anchors, temporary connections, pumps, water, pressure gauges, and other means and facilities required to perform tests.

C. Water for testing, cleaning, and disinfecting shall be from a potable water source located by the OWNER.

D. Pipes to be Tested: Test only those portions of pipes that have been installed as part of this Contract. Test new pipe sections prior to making final connections to existing piping. Furnish and install test plugs, bulkheads, and restraints required to isolate new pipe sections. Do not use existing valves as test plug or bulkhead.

E. Unsuccessful Tests:
   1. Where tests are not successful, correct defects or remove defective piping and appurtenances and install piping and appurtenances that comply with the specified requirements.
   2. Repeat testing until tests are successful.

F. Test Completion: Drain and leave piping clean after successful testing.

G. Test Water Disposal: Dispose of testing water in accordance with requirements of federal, state, county, and city regulations governing disposal of wastes in the location of the Project and disposal site.

1.04 SUBMITTALS

A. Schedule and Notification of Tests:
   1. Submit a list of scheduled piping tests by noon of the working day preceding the date of the scheduled tests.
   2. Notification of Readiness to Test: Immediately before testing, notify ENGINEER in writing of readiness, not just intention, to test piping. Have personnel, materials, and equipment specified in place before submitting notification of readiness.

1.05 SEQUENCE

A. Clean piping before pressure or leak tests.

B. Test gravity piping underground, including sanitary sewers, for visible leaks before backfilling and compacting.

C. Underground pressure piping may be tested before or after backfilling when not indicated or specified otherwise.

D. Backfill and compact trench, or provide blocking that prevents pipe movement before testing underground piping with a maximum leakage allowance.

E. Test underground piping before encasing piping in concrete or covering piping with slab, structure, or permanent improvement.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

3.01 TESTING ALIGNMENT, GRADE, AND DEFLECTION

A. Alignment and Grade:
   1. Visually inspect the interior of gravity piping with artificial light, reflected light, or laser beam.
   2. Consider inspection complete when no broken or collapsed piping, no open or poorly made joints, no grade changes that affect the piping capacity, or no other defects are observed.

B. Deflection Test:
   1. Pull a mandrel through the clean piping section under test.
   2. Perform the test not sooner than 30 days after installation and not later than 60 days after installation.
   3. Use a 9 rod mandrel with a contact length of not less than the nominal diameter of the pipe within one percent plus or minus.
   4. Consider test complete when the mandrel can be pulled through the piping with reasonable effort by 1 person, without the aid of mechanical equipment.

3.02 AIR TESTING METHOD FOR PRESSURE PIPING

A. Air test piping, indicated with "AM" in the Piping Schedule, with air or another nonflammable or inert gas.

B. Test air and chlorine gas piping by the air test method. Test chlorine piping with dry air or nitrogen having a dew point of minus 40 degrees Fahrenheit or less. Supply temporary air dryers as necessary.

C. Test at pressure as specified in Piping Schedule in Section 15052.
   1. Provide temporary pressure relief valve for piping under test. Set at the lesser of 110 percent of the test pressure or 50 pounds per square inch gauge over the test pressure.
   2. Air method test pressures shall not exceed 110 percent of the piping maximum allowable working pressure calculated in accordance with the most stringent of ANSI/ASME B31.1, ANSI/ASME B31.3, ANSI/ASE B31.8, or the pipe manufacturer's stated maximum working pressure.
   3. Gradually increase test pressure to an initial test pressure equal to the lesser of one-half the test pressure or 25 pounds per square inch gauge.
   4. Perform initial check of joints and fittings for leakage.
   5. Gradually increase test pressure in steps no larger than the initial pressure. Check for leakage at each step increase until test pressure reached.
   6. At each step in the pressure, examine and test piping being air tested for leaks with soap solution.
   7. Consider examination complete when piping section under test holds the test pressure for 15 minutes without losses.

3.03 TESTING GRAVITY FLOW PIPING

A. Test gravity flow piping indicated with "GR" in the Piping Schedule, as follows:
   1. Unless specified otherwise, subject gravity flow piping to the following tests:
      a. Alignment and grade.

b. For plastic piping test for deflection.
c. Visible leaks and pressure with maximum leakage allowance, except for storm drains and culverts.

2. Inspect piping for visible leaks before backfilling. Provide temporary restraints when needed to prevent movement of piping. Pressure test piping with maximum leakage allowance after backfilling.
3. With the lower end plugged, fill piping slowly with water while allowing air to escape from high points. Keep piping full under a slight head for the water at least 24 hours.
   a. Examine piping for visible leaks. Consider examination complete when no visible leaks are observed.
   b. Maintain piping with water, or allow a new water absorption period of 24 hours for the performance of the pressure test with maximum leakage allowance.
   c. After successful completion of the test for visible leaks and after the piping has been restrained and backfilled, subject piping to the test pressure for minimum of four hours while accurately measuring the volume of water added to maintain the test pressure.
      1) Consider the test complete when leakage is equal to or less than the following maximum leakage allowances:
         a) For Concrete Piping with Rubber Gasket Joints: 80 gallons per day per inch of diameter per mile of piping under test. Advise manufacturer of concrete piping with rubber gasket joints of more stringent than normal maximum leakage allowance.
         b) For Vitrified Clay and Other Piping: 500 gallons per day per inch of diameter per mile of piping under test.

3.04 TESTING HIGH-HEAD PRESSURE PIPING

A. Test piping for which the specified test pressure in the Piping Schedule is 20 pounds per square inch gauge or greater, by the high head pressure test method, indicated "HH" in the Piping schedule.

B. General:
   1. Test connections, hydrants, valves, blowoffs, and closure pieces with the piping.
   2. Do not use installed valves for shutoff when the specified test pressure exceeds the valve's maximum allowable seat differential pressure. Provide blinds or other means to isolate test sections.
   3. Do not include valves, equipment or piping specialties in test sections if test pressure exceeds the valve, equipment or piping specialty safe test pressure allowed by the item's manufacturer.
   4. During the performance of the tests, test pressure shall not vary more than plus or minus five pounds per square inch gauge with respect to the specified test pressure.
   5. Select the limits of testing to sections of piping. Select sections that have the same piping material and test pressure.
   6. When test results indicate failure of selected sections, limit tests to piping:
      a. Between valves.
      b. Between a valve and the end of the piping.
      c. Less than 500 feet long.

7. Test piping for minimum 2 hours for visible leaks test and minimum 2 hours for the pressure test with maximum leakage allowance.

C. Testing Procedures:
   1. Fill piping section under test slowly with water while venting air. Use potable water for all potable waterlines and where noted on the Piping Schedule.
   2. Before pressurizing for the tests, retain water in piping under slight pressure for a water absorption period of minimum 24 hours.
   3. Raise pressure to the specified test pressure and inspect piping visually for leaks. Consider visible leakage testing complete when no visible leaks are observed.

D. Pressure Test with Maximum Leakage Allowance:
   1. Leakage allowance is zero for piping systems using flanged, National Pipe Thread threaded and welded joints.
   2. Pressure test piping after completion of visible leaks test.
   3. For piping systems using joint designs other than flanged threaded or welded joints, accurately measure the makeup water necessary to maintain the pressure in the piping section under test during the pressure test period.
      a. Consider the pressure test to be complete when makeup water added is less than the allowable leakage and no damage to piping and appurtenances has occurred.
      b. Successful completion of the pressure test with maximum leakage allowance shall have been achieved when the observed leakage during the test period is equal or less than the allowable leakage and no damage to piping and appurtenances has occurred.
      c. When leakage is allowed, calculate the allowable leakage by the following formula:

         $L = S \times D \times P^{1/2} \times 133{,}200^{-1}$

         wherein the terms shall mean:

         L = Allowable leakage in gallons per hour.

         S = Length of the test section in feet.

         D = Nominal diameter of the piping in inches.

         P = Average observed test pressure in pounds per square inches, gauge, at the lowest point of the test section, corrected for elevation of the pressure gauge.

         x = The multiplication symbol.

3.05 TESTING LOW-HEAD PRESSURE PIPING

A. Test piping for which the specified test pressure is less than 20 pounds per square inch gauge, by the low head pressure test method, indicated "LH" in the Piping Schedule.

B. Test pressures shall be as scheduled in Section 15052.

C. During the performance of the tests, test pressure shall not vary more than plus or minus 2 pounds per square inch gauge with respect to the specified test pressure.

D. Test connections, blowoffs, vents, closure pieces, and joints into structures, including existing bell rings and other appurtenances, with the piping.

E. Test piping for minimum 2 hours for visible leaks test and minimum 2 hours for the pressure test with maximum leakage allowance.

F. Visible Leaks Test:
   1. Subject piping under test to the specified pressure measured at the lowest end.
   2. Fill piping section under test slowly with potable water while venting air.
   3. Before pressurizing for the tests, retain water in piping under slight pressure for the water absorption period of minimum 24 hours.
   4. Raise pressure to the specified test pressure and inspect piping visually for leaks. Consider testing complete when no visible leaks are observed.

G. Pressure Test with Maximum Leakage Allowance:
   1. Pressure test piping after completion of visible leaks test.
   2. Accurately measure the makeup water necessary to maintain the pressure in the piping section under test during the pressure test period.
      a. Consider the pressure test to be complete when makeup water added is less than the allowable leakage of 80 gallons per inch of nominal diameter, per mile of piping section under test after 24 hours and no damage to piping and appurtenances has occurred.
      b. Successful completion of the leakage test shall have been achieved when the observed leakage is equal or less than the allowable leakage and no damage to piping and appurtenances has occurred.

END OF SECTION

SECTION 15958

MECHANICAL EQUIPMENT TESTING

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes: Testing of mechanical equipment and systems.

B. Related Sections:
1. Section 01756 - Testing, Training, and Facility Start-Up.
2. Section 02318 - Trenching.
3. Section 15956 - Piping Systems Testing.
4. Section 16222 - Low Voltage Motors up to 500 Horsepower.
5. Section 16950 - Field Electrical Acceptance Tests.
6. Section 17950 - Testing, Calibration, and Commissioning.

1.02 REFERENCES

A. American National Standards Institute (ANSI):
1. ANSI S1.4 Specification for Sound Level Meters.

B. American National Standards Institute/Hydraulic Institute (ANSI/HI):
1. ANSI/HI 1.1-1.5 Standard for Centrifugal Pumps for Nomenclature, Definitions, Application and Operation.
2. ANSI/HI 1.6 Standard for Centrifugal Pump Tests.
3. ANSI/HI 2.1-2.5 Standard for Vertical Pumps for Nomenclature, Definitions, Application and Operation.
4. ANSI/HI 2.6 Standard for Vertical Pump Tests.
5. ANSI/HI 3.1-3.5 Standard for Rotary Pumps for Nomenclature, Definitions, Application and Operation.
6. ANSI/HI 3.6 Standard for Rotary Pump Tests.
7. ANSI/HI 4.1-4.6 Standard for Sealless Rotary Pumps for Nomenclature, Definitions, Application, Operation and Test.
8. ANSI/HI 5.1-5.6 Standard for Sealless Centrifugal Pumps for Nomenclature, Definitions, Application, Operation and Test.
9. ANSI/HI 6.1-6.5 Standard for Reciprocating Power Pumps for Nomenclature, Definitions, Application and Operation.
10. ANSI/HI 6.6 Standard for Reciprocating Pump Tests.
11. ANSI/HI 7.1-7.5 Standard for Controlled Volume Pumps for Nomenclature, Definitions, Application and Operation.
12. ANSI/HI 8.1-8.5 Standard for Direct Acting for Steam Pumps for Nomenclature, Definitions, Application and Operation.
13. ANSI/HI 9.1-9.5 Standard for Pumps - General Guidelines for Types, Definitions, Application and Sound Measurement.

1.03 SUBMITTALS

A. Schedule of factory tests and field tests as specified in Section 01756 and this Section.

B. Test instrumentation calibration data.

C. Start-up plan as specified in Section 01756.

D. Test Plan specified in this Section.

E. Test result reports.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

3.01 QUALITY CONTROL TESTING AND REPORTING

A. Scheduling and Notification:
   1. Witnessed Source Quality Control Tests: Schedule test date and notify ENGINEER at least 30 days prior to start of test.
   2. Field Quality Control Tests: Schedule test date and notify ENGINEER at least 7 days prior to start of test.

B. Testing Levels:
   1. Test equipment based on test levels specified in the equipment Section of the Specifications.
   2. Requirements for Test Levels 1 to 4 are defined below.
   3. Test levels apply for both Source (Factory) Quality Control Tests and Field Quality Control Tests as specified in the individual equipment Sections of the Specifications.
   4. If testing is not specified in the equipment Section, provide Level 1 testing.
   5. Requirements of Section 01756 apply to Test Levels.

C. Witnessing: Source Quality Control Tests not witnessed unless specified otherwise in the equipment specification Section or Section 01756; Field Quality Control Tests shall be witnessed.

D. Instrumentation: Provide necessary test instrumentation which has been calibrated within one year from date of test to recognized test standards traceable to the National Institute of Standards and Technology, Washington, D.C. or approved source. Properly calibrated field instrumentation permanently installed as a part of the Work may be utilized for Field Quality Control Tests.

E. Temporary Facilities and Labor: Provide necessary fluids, utilities, temporary piping, temporary supports, temporary access platforms or access means and other temporary facilities and labor necessary to safely operate the equipment and

accomplish the specified testing. With OWNER's permission, some utilities may be provided by fully tested permanently installed utilities that are part of the Work.

F. Test Fluids:
   1. Factory Tests: Use water or air as appropriate at ambient conditions unless specified otherwise in the equipment Section.
   2. Field Tests: Use specified process fluid at available conditions.

G. Pressure Testing: Hydrostatically pressure test pressure containing parts in the factory at the appropriate standard or code required level above the equipment component specified design pressure or operating pressure, whichever is higher. Submit pressure test reports before shipping.

H. Test Measurement and Result Accuracy:
   1. Use test instruments with accuracies as recommended in the appropriate referenced standards. When no accuracy is recommended in the referenced standard, use 1 percent or better accuracy test instruments. Improved (lower error tolerance) accuracies specified elsewhere prevail over this general requirement.
   2. Do not adjust results of tests for instrumentation accuracy. Measured values and values directly calculated from measured values shall be the basis for comparing actual equipment performance to specified requirements.

I. Field Testing:
   1. Submit test plan as specified in Section 01756 and this Section. Indicate test start time and duration, equipment to be tested, other equipment involved or required; temporary facilities required, number and skill or trade of personnel involved; safety issues and planned safety contingencies; anticipated effect on OWNER's existing equipment and other information relevant to the test. Provide locations of all instruments to be used for testing. Provide calibration records for all instrumentation.
   2. Perform general start-up and testing procedures as specified in Section 01756.
   3. Prior to testing, verify equipment protective devices and safety devices have been installed, calibrated, and tested.

J. Reports: Submit reports for Source and Field testing. Submit Source Quality Control Test result reports before shipping equipment to the field. Report features:
   1. Report results in a bound document in generally accepted engineering format with title page, written summary of results compared to specified requirements, and appropriate curves or plots of significant variables in English units.
   2. Include appendix with a copy of raw, unmodified test data sheets indicating test value, date and time of reading, and initials of person taking the data.
   3. Include appendix with sample calculations for adjustments to raw test data and for calculated results.
   4. Include appendix with the make, model, and last calibration date of instrumentation used for test measurements.
   5. Include in body of report a drawing or sketch of the test system layout showing location and orientation of the test instruments relative to the tested equipment features.

3.02 EQUIPMENT TESTING, GENERAL

A. Tests for Pumps, All Levels of Testing:
   1. Test in accordance with applicable Hydraulic Institute Standards in addition to the requirements in this and other Sections.
   2. Test Tolerances: In accordance with appropriate Hydraulic Institute Standards, except the following modified tolerances apply:
      a. From 0 to plus 5 percent of head at the specified flows.
      b. From 0 to plus 5 percent of flow at the rated design point head.
      c. No negative tolerance for the efficiency at the specified flows.
      d. No positive tolerance for vibration limits. Vibration limits and test methods in Hydraulic Institute Standards do not apply, use limits and methods specified in this or other Sections of the Specifications.

B. Tests for Drivers: Test motors as specified in Section 16222. Test other drivers as specified in the driver equipment Section.

3.03 REQUIREMENTS FOR VIBRATION TESTING

A. Definitions:
   1. Peak to Peak Displacement: The root mean squared average of the peak to peak displacement multiplied by the square root of 2.
   2. Peak Velocity: The root mean squared average of the peak velocity multiplied by the square root of 2.
   3. Peak Acceleration: The root mean squared average of the peak acceleration multiplied by the square root of 2.
   4. High Frequency Enveloping: A process to extract very low amplitude time domain signals associated with impact or impulse events such as bearing or gear tooth defects and display them in a frequency spectrum of acceleration versus frequency. Manufacturers: One of the following or equal:
      a. Rockwell Automation, Entek Group, "Spike Energy" analysis.
      b. CSI, "PeakVue."
   5. Low Speed Equipment: Equipment or components of equipment rotating at less than 600 revolutions per minute.
   6. High Speed Equipment: Equipment and equipment components operating at or above 600 revolutions per minute.

B. Vibration Instrumentation Requirements:
   1. Analyzers: Use digital type analyzers or data collectors with anti-aliasing filter, 12 bit A/D converter, fast fourier transform circuitry, phase measurement capability, time wave form data storage, high frequency enveloping capabilities, 35 frequency ranges from 21 to 1,500,000 cycles per minute, adjustable fast fourier transform resolution from 400 to 6,400 lines, storage for up to one hundred 3,200 line frequency spectra, RS232C data output port, circuitry for integration of acceleration data to velocity or double integration to displacement. Manufacturers: One of the following or equal:
      a. Entek-IRD, Division of Rockwell Automation, Enpac 1200 with applicable data analysis software or Entek Model 838 analyzer with built in printer.
      b. Computational Systems Inc., (CSI) Division of Emerson Electric, Model 2120A, Data Collector/analyzer with applicable analysis software.
   2. Analyzer Settings:
      a. Units: English, inches/second, mils, and g's.

b. Fast Fourier Transform Lines: Most equipment 1,600 minimum; for motors, enough lines as required to distinguish motor current frequencies from rotational frequencies, use 3,200 lines for motors with a nominal speed of 3,600 rpm; 3,200 lines minimum for High Frequency Enveloping; 1,600 lines minimum for low speed equipment.
c. Sample Averages: 4 minimum
d. Maximum Frequency (Fmax): 40 times rotational frequency for rolling element bearings, 10 times rotational frequency for sleeve bearings.
e. Amplitude Range: Auto select but full scale not more than twice the acceptance criteria or the highest peak, whichever is lower.
f. Fast Fourier Transform Windowing: Hanning Window.
g. High Pass Filter: Minus 3 dB at 120 cycles per minute for high speed equipment. Minus 3 dB at 21 cycles per minute for low speed equipment.

3. Accelerometers:
   a. For Low Speed Equipment: Low frequency, shear mode accelerometer, 500 millivolts per g sensitivity, 10 g range, plus/minus 5 percent frequency response from 0.5 hertz to 850 hertz, magnetic mount. Manufacturers: One of the following or equal:
      1) Wilcoxon Research, Model 797L.
      2) PCB, Model 393C.
   b. For High Speed Equipment: General purpose accelerometer, 100 millivolts per g sensitivity, 50 g range, plus/minus 3dB frequency response range from 2 hertz to 12,000 hertz when stud mounted, with magnetic mount holder. Manufacturers: One of the following or equal:
      1) Wilcoxon Research, Model 793.
      2) Entek-IRD Model 943.

C. Accelerometer Mounting:
   1. Use magnetic mounting or stud mounting.
   2. Mount on bearing housing in location with best available direct path to bearing and shaft vibration.
   3. Remove paint and mount transducer on flat metal surface or epoxy mount for High Frequency Enveloping measurements.

D. Vibration Testing Results Presentation:
   1. Provide equipment drawing with location and orientation of measurement points indicated.
   2. For each vibration measurement take and include appropriate data on equipment operating conditions at the time vibration data is taken; for pumps, compressors, and blowers record suction pressure, discharge pressure, and flow.
   3. When Vibration Spectra Data Required:
      a. Plot peak vibration velocity versus frequency in cycles per minute.
      b. Label plots showing actual shaft or part rotation frequency, bearing inner and outer race ball pass frequencies, gear mesh frequencies and relevant equipment excitation frequencies on the plot; label probable cause of vibration peaks whether in excess of specification limits or not.
      c. Label plots with equipment identification and operating conditions such as tag number, capacity, pressure, driver horsepower, and point of vibration measurement.
      d. Plot motor spectra on a log amplitude scale versus frequency.

4. For low speed equipment, plot peak vibration displacement versus frequency as well as velocity versus frequency.
5. Provide name of manufacturer and model number of the vibration instrumentation used, including analyzer and accelerometer used together with mounting type.

3.04 TESTING LEVELS

A. Level 1 Quality Control Tests:
   1. Level 1 General Equipment Performance Test:
      a. For equipment, operate, rotate, or otherwise functionally test for 15 minutes minimum after components reach normal operating temperatures.
      b. Operate at rated design load conditions.
      c. Confirm that equipment is properly assembled, equipment moves or rotates in the proper direction, shafting, drive elements and bearings are installed and lubricated in accordance with proper tolerances, and that no unusual power consumption, lubrication temperatures, bearing temperatures, or other conditions are observed.
   2. Level 1 Pump Performance Test:
      a. Measure flow and head while operating at or near the rated condition; for factory testing, testing may be at reduced speeds with flow and head corresponding to the rated condition when adjusted for speed using the appropriate affinity laws.
      b. Use of a test driver is permitted for factory tests when actual driver is given a separate test at its point of manufacture as specified in Section 16222 or the applicable equipment Section. Use actual driver for field tests.
      c. Record measured flow, suction pressure, discharge pressure, and make observations on bearing temperatures and noise levels.
   3. Level 1 Vibration Test:
      a. Test Requirement:
         1) Measure filtered vibration spectra versus frequency in three perpendicular planes at each normally accessible bearing housing on the driven equipment, any gears and on the driver; one plane of measurement to be parallel to the axis of rotation of the component.
         2) Vibration spectra versus frequency shall be in accordance with paragraph 15958-3.07.
      b. Equipment Operating Condition: Test at specified maximum speed.
   4. Level 1 Noise Test:
      a. Measure unfiltered overall A-weighted sound pressure level in dBA at 3 feet horizontally from the surface of the equipment and at a mid-point of the equipment height.

B. Level 2 Quality Control Tests:
   1. Level 2 General Performance Test:
      a. For equipment, operate, rotate, or otherwise functionally test for at least 2 hours after components reach normal operating temperatures.
      b. Operate at rated design load conditions.
      c. Confirm that equipment is properly assembled, equipment moves or rotates in the proper direction, shafting, drive elements and bearings are installed and lubricated in accordance with proper tolerances, and that no

unusual power consumption, lubrication temperatures, bearing temperatures, or other conditions are observed.

2. Level 2 Pump Performance Test:
   a. Test 2 hours minimum for flow and head at the rated condition; for factory testing, testing may be at a reduced speeds with flow and head corresponding to the rated condition when adjusted for speed using the appropriate affinity laws.
   b. Use of a test driver is permitted for factory tests when actual driver is given a separate test at its point of manufacture as specified in Section 16222. Use actual driver for field tests.
   c. Test for flow and head at two additional conditions; one at 25 percent below the rated flow and one at 10 percent above the rated flow.
   d. Record measured flow, suction pressure, discharge pressure, and observations on bearing temperatures and noise levels at each condition.
3. Level 2 Vibration Test:
   a. Test Requirement:
      1) Measure filtered vibration spectra versus frequency and measure vibration phase in three perpendicular planes at each normally accessible bearing housing on the driven equipment, any gears and on the driver; one plane of measurement to be parallel to the axis of rotation of the component; measure actual rotational speeds for each vibration spectra measured using photometric or other tachometer input connected directly to the vibration data collector.
      2) Vibration spectra versus frequency shall be in accordance with paragraph 15958-3.07.
   b. Equipment Operating Condition: Repeat test requirements at design specified maximum speed and at minimum speed for variable speed equipment.
   c. Natural Frequency Test of Field Installed Equipment:
      1) Excite the installed equipment and support system in 3 perpendicular planes, use same planes as operating vibration measurement planes, and determine the as-installed natural resonant frequency of the driven equipment, the driver, gears and supports.
      2) Perform test at each bearing housing, at each support pedestal, and for pumps on the suction and discharge piping.
      3) Perform with equipment and attached piping full of intended service or process fluid.
4. Level 2 Noise Test:
   a. Measure filtered A-weighted overall sound pressure level in dBA for each of 8 octave band mid-points beginning at 63 hertz measured at 3 feet horizontally from the surface of the equipment at mid-point height of the noise source.

C. Level 3 Quality Control Tests:
   1. Level 3 General Equipment Performance Tests:
      a. For equipment, operate, rotate, or otherwise functionally test for at least 4 hours after components reach normal operating temperatures.
      b. Operate at rated design load conditions for one half the specified time; operate at each of any other specified conditions for a proportionate share of the remaining test time.
      c. Confirm that equipment is properly assembled, equipment rotates in the proper direction, shafting and bearings are installed and lubricated in

accordance with proper tolerances, and that no unusual noise, vibration or temperatures are observed.

d. Take appropriate capacity, power or fuel consumption, torque, revolutions per minute, pressure and temperature readings using appropriate test instrumentation to confirm equipment meets specified performance requirements at the design rated condition.

e. Bearing Temperatures: During maximum speed or capacity performance testing, measure and record the exterior surface temperature of each bearing versus time.

2. Level 3 Pump Performance Test:
   a. Test 4 hours minimum for flow and head at or near the rated condition; for factory testing, testing may be at a reduced speeds with flow and head corresponding to the rated condition when adjusted for speed using the appropriate affinity laws.
   b. Use of a test driver is permitted for factory tests when actual driver is given a separate test at its point of manufacture as specified in Section 16222. Use actual driver for field tests.
   c. Test each specified flow and head condition at the rated speed and test at minimum as well as maximum specified speeds; operate at each test condition for a minimum of 15 minutes; for factory testing, test at other speeds may be omitted if test driver at reduced speeds is used for rated condition testing.
   d. Record measured shaft revolutions per minute, flow, suction pressure, discharge pressure; record measured bearing temperatures (bearing housing exterior surface temperatures may be recorded when bearing temperature devices are not required by the equipment specification) and record observations on noise levels.
3. Level 3 Vibration Test:
   a. Requirements: Same as Level 2 vibration test except data taken at each operating condition tested and with additional requirements below.
   b. Perform High Frequency Enveloping Analysis for gears and bearings.
      1) Measure bearing element vibration directly on each bearing cap in a location close as possible to the bearing load zone that provides a smooth surface and direct path to the bearing to detect bearing defects.
      2) Report results in units of acceleration versus frequency in cycles per minute.
   c. Perform Time Wave Form analysis for gears, low speed equipment and reciprocating equipment; plot true peak amplitude velocity and displacement versus time and label the period between peaks with the likely cause of the periodic peaks (relate the period to a cause).
   d. Plot vibration spectra on three different plots; peak displacement versus frequency, peak acceleration versus frequency and peak velocity versus frequency.
4. Level 3 Noise Test: Measure filtered, un-weighted overall sound pressure level in dB at 3 feet horizontally from the surface of the equipment at mid-point height and at four locations approximately 90 degrees apart in plan view; report results for each of 8 octave band mid-points beginning at 63 hertz.

D. Level 4 Quality Control Tests:
   1. Level 4 General Equipment Performance Test:
      a. For equipment, operate, rotate, or otherwise functionally test for at least 8 hours after components reach normal operating temperatures.
      b. Operate at rated design load conditions for one half the specified time; operate at each of any other specified conditions for a proportionate share of the remaining test time.
      c. Confirm that equipment is properly assembled, equipment rotates in the proper direction, shafting and bearings are installed and lubricated in accordance with proper tolerances, and that no unusual noise, vibration or temperatures are observed.
      d. Take appropriate capacity, power or fuel consumption, torque, revolutions per minute, pressure and temperature readings using appropriate test instrumentation to confirm equipment meets specified performance requirements at the design rated condition.
      e. Bearing Temperatures: During maximum speed or capacity testing, measure and record the exterior surface temperature of each bearing versus time.
   2. Level 4 Pump Performance Test:
      a. Test 8 hours minimum for flow and head; begin tests at or near the rated condition; for factory and field testing, test with furnished motor at full speed.
      b. Test each specified flow and head condition at the rated speed and test at minimum as well as maximum specified speeds; operate at each test condition for a minimum of 20 minutes or longer as necessary to measure required performance, vibration and noise data at each test condition.
      c. Record measured shaft revolutions per minute, flow, suction pressure, discharge pressure; record measured bearing temperatures (bearing housing exterior surface temperatures may be recorded when bearing temperature devices not required by the equipment specification) and record observations on noise levels.
      d. Bearing Temperatures: During maximum speed or capacity testing, measure and record the exterior surface temperature of each bearing versus time.
      e. Perform efficiency and/or Net Positive Suction Head Required (NPSHr) and/or priming time tests when specified in the equipment Section in accordance with the appropriate ANSI/HI standard and as follows:
         1) Perform NPSHr testing at maximum rated design speed, head and flow with test fluids at ambient conditions; at maximum rated speed, test at 15 percent above rated design flow, and 25 percent below rated design flow.
         2) Perform efficiency testing with test fluids at maximum rated speed.
         3) Perform priming time testing with test fluids at maximum rated speed.
   3. Level 4 Vibration Test: Same as Level 3 vibration test.
   4. Level 4 Noise Test: Same as Level 3 Noise Test except with data taken at each operating condition tested.

3.05 SOURCE QUALITY CONTROL

A. Test equipment as specified for each type of test at the test levels specified in individual equipment sections. Prepare and submit test reports as specified.

B. Inspection and Balancing:
   1. Statically and dynamically balance each of the individual rotating parts as required to achieve the required field vibration limits. Statically and dynamically balance the completed equipment rotating assembly and drive shaft components.
   2. Furnish copies of material and component inspection reports including balancing reports for equipment system components and for the completed rotating assembly.

C. Critical Speed of Rotating Equipment: Satisfy the following:
   1. The first lateral and torsional critical speed of all constant, variable, and 2-speed driven equipment that is considered rigid such as horizontal pumps, all non-clog pumps, blowers, air compressors, and engines shall be at least 25 percent above the equipment's maximum operating speed.
   2. The first lateral and torsional critical speed of all constant, variable, and 2-speed driven equipment that is considered flexible or flexibly mounted such as vertical pumps (vertical in-line and vertical non-clog pumps excluded) and fans shall at least 25 percent below the equipment's lowest operating speed.
   3. The second lateral and torsional critical speed of all constant, variable, and 2-speed equipment that is considered flexible or flexibly mounted shall be at least 25 percent above the maximum operating speed.

3.06 FIELD QUALITY CONTROL

A. Test equipment as specified for each type of test at the test levels specified in individual equipment Sections. Prepare and submit test reports as specified. Comply with latest version of applicable standards.

B. For variable speed equipment, conduct test to establish performance over the entire speed range and at the average operating condition. Establish performance curves for:
   1. The speed corresponding to the rated maximum capacity.
   2. The speed corresponding to the minimum capacity.
   3. The speed corresponding to the average operating conditions.

3.07 VIBRATION ACCEPTANCE CRITERIA

A. Testing of Rotating Mechanical Equipment: Tests are to be performed by an experienced, factory trained, and independent authorized vibration analysis expert.

B. Vibration Displacement Limits: Unless otherwise specified, equipment operating at speeds 600 RPM or less is not to exhibit unfiltered readings in excess of following:

Operating Speed (revolutions per minute)	**Unfiltered (Overall) Peak-to-Peak Amplitude (mils)**
	All Rotating Equipment
0 - 300	6.5
301 - 600	4.5
Note: For all equipment, axial shaft displacements not to exceed 50 percent of the maximum radial shaft displacements shown in the table relative to the casing.	

C. Vibration Velocity Limits: Unless otherwise specified, equipment operating at speeds greater than 600 rpm is not to exceed the following peak velocity limits:

Item	Unfiltered Overall Limit (inches per second)	Any Filtered Peak Limit (inches per second)
Non-Clog Solids Handling Centrifugal Pumps	0.35	0.25
Horizontal and Vertical In-Line Centrifugal Pumps (other than Non-Clog type)	0.18 (Input BHP 25 or less)	0.14 (Input BHP 25 or less)
	0.22 (Input BHP more than 25 but less than 100)	0.18 (Input BHP more than 25 but less than 100)
	0.25 (Input BHP 100 or more)	0.20 (Input BHP 100 or more)
Vertical Turbine, Mixed Flow, and Propeller Pumps	0.31 (Input BHP 100 or less)	0.22
	0.35 (Input BHP 125 or more)	0.25
Vertical Turbine, Mixed Flow, and Propeller Short Set Pumps	0.28 (Input BHP 100 or less)	0.21
	0.33 (Input BHP 125 or more)	0.24
Motors	See Applicable Motor Specification	
Gear Reducers, Radial	Not to exceed AGMA 6000-A88 limits	
Other Reducers, Axial	0.10	0.10
Centrifugal Blowers	0.15	0.10
Other Equipment, Radial	0.16	0.10
Other Equipment, Axial	0.10	0.10

D. Equipment Operation: Measurements are to be obtained with equipment installed and operating within capacity ranges specified and without duplicate equipment running.

E. Additional Criteria:
1. No narrow band spectral vibration amplitude components, whether sub-rotational, higher harmonic, or synchronous multiple of running speed, are to exceed 40 percent of synchronous vibration amplitude component without manufacturer's detailed verification of origin and ultimate effect of such excitation.
2. The presence of discernable vibration amplitude peaks in Test Level 2 or 3 vibration spectra at bearing inner or outer race frequencies shall be cause for rejection of the equipment.
3. For Motors, the Following Shall be Cause for Rejection:
   a. Stator eccentricity evidenced by a spectral peak at 2 times electrical line frequency that are more than 40 percent of the peak at rotational frequency.

b. Rotor eccentricity evidenced by a spectral peak at 2 times electrical line frequency with spectra side bands at the pole pass frequency around the 2 times line frequency peak.
c. Other rotor problems evidenced by pole pass frequency side bands around operating speed harmonic peaks or 2 times line frequency side bands around rotor bar pass frequency or around two times the rotor bar pass frequency.
d. Phasing problems evidenced by one third line frequency side band spectral peaks around the 2 times electrical line frequency peak.

4. The presence of peaks in a High Frequency Enveloping spectra plot corresponding to bearing, gear or motor rotor bar frequencies or harmonics of these frequencies shall be cause for rejection of the equipment; since inadequate lubrication of some equipment may be a cause of these peaks, lubrication shall be checked, corrected as necessary and the high frequency envelope analysis repeated.

3.08 NOISE REQUIREMENTS AND CONTROL

A. Make measurements in relation to reference pressure of 0.0002 microbar.

B. Make measurements of emitted noise levels on sound level meter meeting or exceeding ANSI S1.4, Type II.

C. Set sound level meter to slow response.

D. Unless otherwise specified, maximum free field noise level not to exceed 85 dBA measured as sound pressure level at 3 feet from the equipment.

3.09 FUNCTIONAL AND OPERATIONAL TESTING OF EQUIPMENT

A. Functional testing as specified in Section 01756 and this Section.

B. General Checkout: Prior to operating equipment, inspect, test, and check supporting systems, including but not limited to power systems, control systems, piping systems, lubrication systems, and safety systems.
1. Test and calibrate instrumentation and electrical devices as specified in Sections 16950 and 17950.
2. Test and prepare piping as specified in Sections 02318 and 15956.
3. As a minimum for control systems associated with the equipment, perform the following:
   a. Individual Loop Tests: Test from field device to intermediate terminations to controller and back to controlled element.
   b. End to End Test: Simulate input at field device and observe control system response at the final field control element.
4. Prior to testing, provide signed and dated certificates of calibration for test instrumentation and equipment.

C. Operation of Related Existing Equipment: OWNER will operate related existing equipment or facilities necessary to accomplish the testing.

D. Acceptable Tests: Demonstrate the equipment performance meets the requirements of this Section and the equipment Section; when the equipment fails to meet the specified requirements, perform additional more detailed testing to determine the cause, correct, repair, or replace the causative components and repeat the testing that revealed the deficiency.

E. Operational Testing: As specified in Section 01756.

END OF SECTION

SECTION 16010

ELECTRICAL REQUIREMENTS

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes: Electrical distribution system and utilization equipment.

B. Related Sections:
   1. Section 16062 - Grounding.
   2. Section 16075 – Electrical Identification.
   3. Section 16950 - Electrical Testing.

1.02 SYSTEM DESCRIPTION

A. Furnish and install a tested and working electrical system, as indicated on the Drawings and as specified. System includes all items not specifically mentioned in these Specifications or indicated on the Drawings or accepted Shop Drawings, but which are obviously necessary to make a complete working installation, and shall be deemed to be included herein.

B. Notify ENGINEER of discrepancies within the Contract Documents and discrepancies between the Contract Documents and actual field conditions.

C. The Specifications and Drawings indicate or specify minimum sizes of equipment, electric devices, and other components of electrical system, but the Specifications and Drawings do not indicate every offset and fitting, or every structural or mechanical difficulty that may be encountered during the execution of the Work.

D. Install equipment at locations indicated on the Drawings as closely as field conditions permit. Obtain accepted equipment submittal dimensions prior to installing pads and conduits.

E. Make minor variations to alignment of equipment and/or installation of raceway systems to avoid conflict with other portions of the Work.

F. Single Line Diagrams: Single line diagrams indicate circuit voltages for low voltage equipment.
   1. Single line diagrams also indicate wire and conduit sizes, circuit protection rating, and other pertinent data. Use single line diagrams to resolve conflicts.
   2. When not indicated on the Drawings, provide grounding in accordance with NEC Article 250 and as specified in Section 16062.

1.03 PERFORMANCE REQUIREMENTS

A. Operate electrical equipment successfully at full-rated load, without failure, at an ambient air temperature of 50 degrees Celsius, and rated for an altitude of 1,300 feet.

B. Coordination of Electrical Equipment Rating: Verify actual equipment, motor full-load, and locked-rotor current ratings. When providing equipment with different motor full-load and locked-rotor current ratings than indicated on the Drawings, coordinate branch circuit conductor sizes, motor overload protection, motor controllers, control power transformers, and branch circuit overcurrent protection required for equipment provided.

C. Branch Circuit Conductor Current Carrying Capacity: Minimum 125 percent of the full-load current rating of equipment.

D. Branch Circuit Conductor Size: Adequate to prevent voltage drop greater than 2 percent from branch circuit protection device to equipment with equipment running at full-load and rated voltage. Include conductor derating in accordance with ambient temperature and conduit fill requirements.

1.04 SUBMITTALS

A. Shop Drawings and Product Data:
   1. Include data on and details of control devices, fixtures, wire, cables, raceways, and other electrical equipment specified or indicated on the Drawings.

B. Cutting and Patching Requests: Submit for ENGINEER review prior to performing the Work.

C. Project Record Documents:
   1. Include drawings of wiring terminations at electrical equipment including, but not limited to:
      a. Terminal/junction boxes.
      b. Revised Shop Drawings reflecting modifications made during progress of the Work including testing, and revised Specifications and Drawings with conductors identified identically as on the Specifications and Drawings and accepted Shop Drawings. Updated Shop Drawings shall include all drafting work.

D. Acceptance Testing Information and Documents: Submit as specified in Section 16950.

1.05 QUALITY ASSURANCE

A. Regulatory Requirements: Perform electrical work, including connection to electrical equipment integral with mechanical equipment, in accordance with latest published requirements of the following codes and code/standard making organizations, unless other dates indicated below:
   1. American National Standards Institute (ANSI).
   2. American Society for Testing and Materials (ASTM).
   3. Institute of Electrical and Electronics Engineers (IEEE).
   4. Insulated Cable Engineers Association (ICEA).
   5. National Electrical Code (NEC), 2008.
   6. National Electrical Contractors Association (NECA).
   7. National Electrical Safety Code (NESC).
   8. National Electrical Manufacturers Association (NEMA).
   9. National Fire Protection Association (NFPA).
   10. State and local codes.

11. Uniform Building Code (UBC).

B. When applicable, materials and equipment used in performance of electrical work shall be listed or labeled by Underwriter's Laboratories or other equivalent, recognized, and independent testing laboratory, for the class of service intended.

C. Manufacturer Qualifications:
   1. Low Voltage Equipment: Manufacturer of proposed product with components uniquely selected by engineering review.
      a. Proprietary bussing and enclosure designs listed by UL in manufacturer's own file for minimum 15 years with satisfactory performance record.
      b. Capable of providing warranty for assembly when built-up with components from various manufacturers.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Ship electrical equipment in sealed dust and moisture-proof plastic sheet enclosures. Equipment containing dirt, dust, water, grease, rust, or damaged parts or components may be rejected.

B. Provide for delivery, unloading, transportation, and storage of equipment until installation. Protect electrical and instrumentation equipment from physical and environmental damage. Store and maintain equipment in a weatherproof building until installed.

C. Store electrical equipment, including instrumentation control panels and other enclosures that house electronic equipment rated for a specified ambient or environmental temperature range, in air conditioned buildings to protect equipment from temperatures above 90 degrees Fahrenheit and heated buildings to protect equipment from temperatures below 40 degrees Fahrenheit. Assume liability for the storage facilities or equipment stored therein.

D. Maintain storage facilities in neat condition with utilities. Maintain stored equipment in same condition as when received.

E. Provide continuous access for inspection of stored equipment.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

3.01 PREPARATION

A. Cutting, Patching, and Repairing: Where it becomes necessary to cut into existing work for the purpose of making electrical installations, use core drills for making circular holes. Other demolition methods for cutting or removing shall be reviewed by the ENGINEER prior to starting the work.

3.02 INSTALLATION

A. Corrosion Protection:
   1. Isolate dissimilar metals that may come in contact, except conduit and conduit fittings, with neoprene washers, 9 mil polyethylene tape, or gaskets.
   2. Restore factory finishes which are damaged or rusted to their original new condition in accordance with manufacturer's instructions.

B. Install electrical work prior to placing floors and walls. Provide all sleeves and openings through floors and walls required for passage of all conduits and other raceways. Sleeves shall be rigidly supported and suitably packed or sealed to prevent ingress of wet concrete or water.

C. Provide all insets and hangers required to support raceways and other electrical equipment. If the inserts, hangers, sleeves, or openings, are improperly placed or installed, do all necessary work to rectify the errors.

3.03 CLEANING

A. Clean each piece of electrical equipment added or modified as part of this Project, existing and new, both inside and outside, and retouch equipment to match existing paint.

3.04 PROTECTION

A. Protect products and provide heat to eliminate condensation until acceptance by OWNER.

END OF SECTION

SECTION 16050

BASIC ELECTRICAL MATERIALS AND METHODS

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes: Basic electrical materials and methods.

B. Related Section:
   1. Section 01612 - Seismic Design Criteria.

1.02 REFERENCES

A. American Society for Testing Materials (ASTM):
   1. A 525 - Specification for General Requirements for Steel Sheet, Zinc-Coated (Galvanized), by Hot-Dip Process.

B. National Electrical Manufacturers' Association (NEMA).

1.03 SYSTEM DESCRIPTION

A. Design Requirements:
   1. Connections of electrical equipment to supports shall be designed to resist the operating forces plus seismic forces.
   2. Seismic design shall conform to the requirements of Section 01612. Calculations shall be by a registered civil or structural engineer in the state of Arizona.

1.04 SUBMITTALS

A. Structural calculations for electrical equipment anchorage.

B. Shop drawings and product data.

1.05 WARRANTY

A. Submit manufacturer's standard warranty.

1.06 EXTRA MATERIALS

A. Furnish and install a minimum of 25 percent spare terminal blocks in each terminal/junction box.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Unless specified otherwise indicated on the Drawings, the fabricator of major electrical equipment, such as lighting and distribution panelboards, shall also be the manufacturer of the major devices herein.

2.02 MATERIALS

A. Materials, equipment, and parts comprising any unit or part thereof specified or indicated on the Drawings shall be new and unused, of current manufacture, and of highest grade consistent with the industrial industry standards. Damaged materials, equipment, and parts are not considered to be new and unused and will not be accepted.

2.03 EQUIPMENT

A. Support Channels: Steel, hot-dip galvanized with G90 coating in accordance with ASTM A 525, or stainless steel.
   1. Manufacturers: One of the following or equal:
      a. Unistrut.
      b. Superstrut.
      c. Globe Strut.

B. Support Channel Bolts, Nuts, and Washers: Stainless steel.

C. Non-Fused Terminal Blocks: Sized as required for conductors.
   1. Manufacturers: One of the following or equal:
      a. Square D Company.
      b. Buchanan.

D. Fused Terminal Blocks: Circuit isolation, fused switch type, sized as required for conductors. Fuse size shall be based upon actual load and conductors to be protected.
   1. Manufacturers: One of the following or equal:
      a. Square D Company.
      b. Buchanan.

E. Control Relays:
   1. Industrial 600 volt, 10 ampere type with contact arrangement and operating coils of proper voltage as required by control circuit sequence; with minimum of 4 reversible-pole contacts; coils sealed by pressure molding.
   2. Non-industrial or plug-in type control relays shall be prohibited unless accepted in writing.
   3. Manufacturers: One of the following or equal:
      a. Square D Company.
      b. Cutler-Hammer.

F. Manual Motor Starters:
   1. Across-the-line manual motor starters for motors up to 1 horsepower, 600 volts shall have the electrical characteristics indicated on the Drawings.

2. Provide single-pole or 3 pole as indicated on the Drawings with overload devices.
3. Provide handles that clearly indicate the ON, OFF with lockout, and TRIPPED positions, pilot light, and positive, quick-make, quick-break mechanisms.
4. Provide enclosures as indicated on the Drawings. Where not indicated, provide NEMA 12 enclosures for indoor location and NEMA 4X enclosures for outdoor locations. Provide enclosures compatible with type of conduit system being used for each specific application.
5. Manufacturers: One of the following or equal:
   a. Cutler-Hammer.
   b. Allen-Bradley.
   c. Square D Company.

PART 3 EXECUTION

3.01 GENERAL

A. Verify dimensions indicated on the Drawings. Actual locations, distances, and levels will be governed by actual field conditions. The CONTRACTOR shall also review information indicated on the Drawings for architectural, structural, yard, mechanical, and other specialties, and the accepted electrical and mechanical shop drawings, and shall adjust his work to conform to all conditions indicated thereon.

B. Coordinate for consistency lens colors of all pilot lights included in all equipment assemblies specified in DIVISIONS 11 through 16 (subject to ENGINEER's acceptance).

C. Supply starter overload trip elements to meet above normal ambient temperatures where such conditions are anticipated (subject to ENGINEER's acceptance).

3.02 EQUIPMENT INSTALLATION

A. Anchor electrical equipment to building floors, electrical equipment foundations, or other supports by bolts and anchor bolts and studs.

B. Anchor electrical equipment with concrete anchors or flush shells only when indicated on the Drawings.

C. Anchor each piece of electrical equipment with minimum 1/2 inch diameter Type 316 stainless steel bolts, anchor bolts, or studs. Acceptable connectors shall be furnished in each corner of each section of electrical equipment, minimum.

3.03 TORQUING

A. After installing and before energizing electrical equipment, torque each bolted bus and cable connection in accordance with manufacturer's recommendations with calibrated torque wrenches. Include each bolt at each connection, both factory and field installed, for motor control centers, variable frequency drives, bus ducts, switchgear, switchboards, and other equipment installed.

3.04 CONDUCTOR FASTENERS

A. Use screw type conductor fasteners and other permanent, such as epoxy conductor adhesives, in junction or pull boxes, termination cabinets, panels, panelboards, switchboards, switchgear, motor control centers, variable frequency drives, or other enclosures containing electrical devices and/or conductors. Do not use glue-on type conductor fasteners.

3.05 SUPPORT CHANNELS

A. Install channels, as required for support of raceways, cable trays, device enclosures, and other electrical equipment.

B. Separate iron or steel supports from aluminum with 1/4 inch neoprene or other non-metallic gaskets.

C. Paint field cuts and scratches of galvanized steel channels with a cold galvanizing spray paint.

3.06 TERMINAL BLOCKS

A. Furnish and install terminal blocks in control panels, cabinets, terminal/junction boxes, variable frequency drives, motor control centers, switchgear, and similar equipment and identify the terminal blocks by numbering and labeling in accordance with accepted shop drawings. The terminal blocks shall be circuit isolation fused-switch type where indicated on the Drawings and as required.

3.07 NAMEPLATES

A. Furnish and install nameplates where indicated on the Drawings or specified.

B. Each disconnect means for service, feeder, branch, or equipment conductors and pushbutton stations shall have nameplates indicating its purpose or identifying the load.

3.08 DEMONSTRATION

A. Demonstrate operation of equipment.

END OF SECTION

SECTION 16062

GROUNDING

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes: Grounding electrode systems, consisting of bare ground conductors.

B. Related Section:
   1. Section 16950 - Electrical Testing.

1.02 REFERENCES

A. National Electrical Code (NEC), Article 250 - Grounding.

PART 2 PRODUCTS

2.01 MATERIALS

A. Ground Conductor: Bare copper.

PART 3 EXECUTION

3.01 INSTALLATION

A. Run grounding electrode system conductors continuously in duct banks, through handholes and other raceway boxes. Connect conductors to structure ground ring or grounding system to provide a continuous grounding electrode system.

B. Bond electrical enclosures, including metallic raceways, panels, switchboards and other similar metallic panels, cases and devices associated with power, instrumentation, and control systems to the grounding electrode system.

C. Provide either exothermic welded or mechanical connections for grounding cable to cable.

D. When size is not indicated on the Drawings, size grounding conductors in accordance with NEC Table 250.66 and Table 250.122.

E. Install a green insulated equipment grounding conductor, or multi-conductor cable with integral green insulated grounding conductor, with each feeder and branch circuit from the power source grounding means to the load equipment or device.

F. Install ground bushings at both ends of rigid conduit runs. Do not use locknuts. Bond ground bushings to the grounding system.

G. When not indicated on the Drawings, install grounding electrode systems in compliance with NEC Article 250.52.

3.02 FIELD QUALITY CONTROL

A. Test ground resistance, as specified in Section 16950, of entire system and at each building/structure where electrical equipment is installed.

B. Invite ENGINEER to witness ground resistance testing.

C. Where maximum allowable ground resistance of 5 ohms is exceeded, install additional grounding mats or ground rods until ground resistance is equal to or below maximum allowable ground resistance.

END OF SECTION

SECTION 16075

ELECTRICAL IDENTIFICATION

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes: Identification of electrical conductors, raceways and equipment, and electrical equipment signs.

1.02 REFERENCES

A. National Electrical Code (NEC):
   1. Article 110.22 - Disconnecting Means.
   2. Article 210.4 - Multiwire Branch Circuits.
   3. Article 200 - Use and Identification of Grounded Conductors.
   4. Article 300 - Wiring Methods.
   5. Article 408 - Switchboards and Panelboards.

1.03 SUBMITTALS

A. Shop Drawings:
   1. Cross Reference: Diagram shall carry a uniform and coordinated set of wire numbers and terminal block numbers to permit cross-referencing between the Contract Document Drawings, the Drawings prepared by the CONTRACTOR, and equipment O&M Manual Drawings.
   2. Drawing number cross references and continuation references shall also be provided. CONTRACTOR-prepared Drawings shall reference applicable CONTRACTOR Drawings such as P&IDs, control and logic diagrams, interface wiring diagrams, Panel Drawings, etc. CONTRACTOR-prepared Drawings shall also reference applicable Drawings provided by equipment manufacturers.
   3. Interconnection Diagrams: Cables shall not be installed into raceways until the wiring interconnection diagrams are reviewed by the design engineer.
   4. Include tagging system, labels, markers, hazard tape, nameplates, and signs.

B. Product Data: Include tagging system, labels, markers, and hazard tape.

C. Project Record Documents:
   1. Document wire, cable, and conductor tags, and bundle tags installed in accordance with the Contract Documents.
   2. Document installed wire, cable, and conductor tags and bundle tags when not specifically indicated.
   3. Indicate on Record Drawings deviations from accepted Shop Drawing conductor identification.

PART 2 PRODUCTS

2.01 LABELS

A. Manufacturers: One of the following or equal:
   1. Brady.
   2. Seton.

B. Type: Sleeve type.

2.02 CONDUCTOR AND CABLE MARKERS

A. Manufacturers: One of the following or equal:
   1. Brady.
   2. Seton.

B. Type: Slip-on PVC sleeve or strap-on type.

C. Printed using Brady marker "XC PLUS," or equal.

D. Markers used in tunnels or other wet locations shall be on heat-shrinkable marking sleeves.

E. Use self-laminating vinyl on white background for markers within electrical equipment such as panels, termination cabinets, motor control centers.

2.03 RACEWAYS IDENTIFICATION (TAGS)

A. Conduit numbers shall be pressure stamped into a noncorrosive 2 inch long, 1/2 inch wide stainless steel tape, Dymo marking system or equal. A tag with number shall be fixed with No. 18 AWG or larger Type 304 stainless steel wire, to each conduit segment and at the end of each conduit and within 3 feet of each pull box, panelboard, and switchboard.

2.04 NAMEPLATES, LABELS AND SIGNS

A. Nameplates:
   1. Type: Black lamicoid with white letters.
   2. Fastener: Round head stainless steel screws.

B. Automatic Equipment and High Voltage Warning Signs:
   1. Type: Suitable for exterior use and meeting OSHA regulations.

PART 3 EXECUTION

3.01 CIRCUIT IDENTIFICATION

A. Identify 3-phase system conductors and cables as Phases A, B, and C and identify 1-phase system conductors and cables at electrical equipment including, but not limited to, switchgear, switchboards, panelboards, motor control centers, and motors.
   1. Match OWNER's existing electrical system identification scheme or meet requirements of the authority responsible for the project.
   2. 3-Phase 480 Volts AC System Conductors: Phase A, brown; Phase B, orange; Phase C, yellow.
   3. Single-Phase Conductors for 120/240 VAC Circuits: Phase A, black; Phase B, red.
   4. Neutral Conductor: White for 120 VAC and gray for 277 VAC.
   5. Insulated Equipment Grounding Conductor: Green.
   6. General Purpose AC Control Conductors: Purple.
   7. General Purpose DC Control Conductors: Purple with white stripes.

B. Use color coding and phasing consistent throughout the site. Bus bars at panelboards and motor control centers to be connected Phase A-B-C, top to bottom, or left to right facing connecting lugs.

C. Conductors Number 2 American Wire Gauge (AWG) and smaller to be factory color coded with a separate color for each phase and neutral, which shall be used consistently throughout the system. Larger cables to be coded by the use of colored tape.

D. In addition to color coding, for all 1-phase and 3-phase systems, identify each cable (single or multi-conductor) and conductor at each end, in each manhole, pullbox, cable tray, or other component of the raceway system. This identification is applicable to all power, control, alarm, signal, instrumentation cables, and conductors.

E. Identify each cable (single or multi-conductor) and groups or bundles of individual single conductors in each manhole, pullbox, cable tray, or other component of the raceway system with circuit identification markers. Implement a "from-to" cable/conductor bundle tagging system as part of this identification effort.

F. Identify each individual conductor at each termination. This includes such locations as switchgear, switchboards, motor control centers, variable frequency drives, control panels, junction/terminal boxes, all field devices, and all other locations where conductors are terminated. Identify the termination of these conductors in accordance with the accepted Shop Drawings. Tag conductors with sleeve type labels.

G. Where more than 1 nominal voltage system exists, identify each ungrounded system conductor by phase and system. Permanently post means of identification at each branch-circuit panelboard, switchboard, switchgear, motor control center, or other type of power distribution equipment.

H. Include the following minimum information for wire and cable identification.
   1. Circuit number or load identification tag number.
   2. Origin (from source).
   3. Destination (to load).

3.02 NAMEPLATES

A. Furnish and install nameplates for all electrical equipment indicated on the Drawings or specified.

B. Each disconnect means for service, feeder, branch, or equipment conductors and pushbutton stations shall have nameplates indicating its purpose or identifying the load.

END OF SECTION

SECTION 16123

600 VOLT OR LESS WIRES AND CABLES

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:
   1. 600 volt class wire and cable.
   2. Instrumentation class wire and cable.

B. Related Sections:
   1. Section 16075 - Electrical Identification.
   2. Section 16134 - Boxes.
   3. Section 16133 - Conduits.
   4. Section 16950 - Electrical Testing.

1.02 REFERENCES

A. American Society for Testing and Materials (ASTM):
   1. B 3 - Standard Specification for Soft or Annealed Copper Wire.
   2. B 8 - Specification for Concentric-Lay–Stranded Copper Conductors, Hard, Medium-Hard, or Soft.

B. Insulated Cable Engineers Association (ICEA).

C. National Electrical Code (NEC):
   1. Article 250 - Grounding.
   2. Article 310 - Conductors for General Wiring.

D. Underwriters' Laboratories, Inc., (UL):
   1. UL 1277 Subject - Electrical Power and Control Tray Cables with Optional Optical-Fiber Members.

1.03 SUBMITTALS

A. Product Data: Include wires, cables, pulling compounds, and splicing materials.

1.04 QUALITY ASSURANCE

A. Conform to ASTM and ICEA standards.

B. Furnish mechanical conductor connector and heat-shrink type insulation by same manufacturer.

PART 2 PRODUCTS

2.01 WIRE AND CABLE MATERIALS

A. Conductors: ASTM B 8, soft drawn copper, maximum 12 months old, minimum 97 percent conductivity. American Wire Gauge (AWG) sizes as indicated on the Drawings, Class B or C stranded.

B. Insulation Thickness: Minimum specified by NEC Article 310.

C. Conductor Sizes: As indicated on wiring schedules and Drawings.

2.02 600-VOLT CLASS CABLE

A. Power Wire and Cable:
   1. Manufacturers: One of the following or equal:
      a. Okonite Company.
      b. BICC Cable.
      c. Southwire Company.

B. Control Wire and Cable:
   1. Manufacturers: One of the following or equal:
      a. Okonite Company.
      b. BICC Cable.
      c. Southwire Company.

C. Insulation for Individual Wires or Multiple Conductor Cable for Power and Control Circuits:
   1. Type THWN-2 insulation for use in dry locations and installed in conduit.
   2. Type XHHW insulation for use in wet locations and underground ductbanks.

D. Jackets for Multiple Conductor Cable for Power and Control Circuits: Type CPE.

E. Tray Cable:
   1. Minimum size Number 1/0 AWG for single wires.
   2. Multi-conductor cable listed and identified on its surface as suitable for cable tray use, Type TC cable in accordance with NEC Article 336.
   3. Multi-Conductor Cables Requiring Connection to Neutral: Provided with integral white insulated conductor with ambient temperature adjustment in accordance with NEC Table 310.16.

F. Multi-Conductor Cable Insulated Grounding Conductors:
   1. Color: Integral green.
   2. Sizes: In accordance with NEC 250.122.

G. Solid-conductor wire, Number 12 AWG, may be used only for lighting and receptacle circuits.

2.03 INSTRUMENTATION CLASS CABLE

A. Single Pair or Triad Applications:
   1. Manufacturers: One of the following or equal:
      a. The Okonite Company, Okoseal-N Type P-OS.
      b. Equivalent manufactured by Cooper Industries, Belden Wire and Cable Division.

B. Multiple Pair or Triad Applications:
   1. Manufacturers: One of the following or equal:
      a. The Okonite Company, Okoseal-N Type SP-OS.
      b. Equivalent manufactured by Cooper Industries, Belden Wire and Cable Division.

C. Approved for cable tray installation in accordance with the National Electrical Code.

D. Number of Individually Shielded, Twisted Pairs, and Triads: As indicated on the Drawings or as necessary for the application.

E. Voltage Rating: 600 volts.

F. Cable Type: TC.

G. Temperature Rating: 90 degrees Celsius dry location, 75 degrees Celsius wet location.

H. Conductors: Bare, soft annealed copper in accordance with ASTM B 3, Class B, 7-strand concentric in accordance with ASTM B 8.

I. Conductor Insulation: Flame-retardant polyvinyl chloride, 15 mils nominal thickness, with nylon jacket 4 mils nominal thickness, 90 degrees Celsius temperature rating in accordance with Underwriter's Laboratory Subject 1277.

J. Color Code: Provide conductor color code as specified in Section 16075.

K. Single Pair or Triad Shielding:
   1. Group Shielding: Minimum 1.35 mil double-faced aluminum/synthetic polymer-backed tape overlapped to provide 100 percent coverage.
   2. Drain Wire: 7-strand tinned copper drain wire, 2 sizes smaller than conductor.

L. Multiple Pair or Triad Shielding:
   1. Group Shield: 1.35 mil aluminum-polyester tape overlapped to provide 100 percent coverage and a 7-strand tinned copper drain wire, 2 sizes smaller than conductor. Completely isolate group shields from each other.
   2. Cable Shield: 2.35 mils double-faced aluminum and synthetic polymer backed tape overlapped to provide 100 percent coverage and a 7-strand tinned copper drain wire, same size as conductors.

M. Jacket: Black, flame-retardant in accordance with Underwriter's Laboratory Subject 1277, 90 degrees Celsius temperature rating, rip cord laid longitudinally under jacket to facilitate removal.

N. Conductor Size: Number 16 AWG minimum unless otherwise indicated on the Drawings.

O. Numerically identify one conductor within each pair and triad.

2.04 RELATED MATERIALS

A. Splicing Material:
   1. In conformance with ANSI C119.1, IEEE 383, and ICEA 5-19-81.
   2. Manufacturers: One of the following or equal:
      a. Elastimold.
      b. Thomas-Betts.
      c. Raychem, FCSM Series.

B. Wire Nuts:
   1. Rated 600 volt with live-spring feature for tight fitting connections.
   2. Manufacturers: One of the following or equal:
      a. 3M.
      b. Thomas and Betts.

C. Junction Boxes and Terminal Cabinets: As specified in Section 16134.

D. Pulling Compound: As recommended by conductor manufacturer.

2.05 WIRE AND CABLE FABRICATION

A. Permanently mark American Wire Gauge (AWG) size, grade of insulation, voltage, and manufacturer's name on outer covering at maximum 24 inch intervals.

B. Identify and mark conductors in accordance with NEC Article 310.

C. Color code wire and cable as specified in Section 16075.
   1. Integrally color insulation for Number 2 AWG and smaller.
   2. Wrap colored tape around cable larger than Number 2 AWG.

D. Fabricate cable ends with provisions for field testing.

2.06 SOURCE QUALITY CONTROL

A. Test full lengths in accordance with ASTM and ICEA Standards.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install continuous circuit conductors from source to load without splices or terminations in intermediate manholes or pull boxes, except for Number 10 AWG and smaller conductors for lighting and receptacles.

B. Splices:
   1. Where splices are necessary because of extremely long wire or cable lengths that exceed standard manufactured lengths, install and label junction boxes for power conductors or termination cabinets for control and instrument conductors.
   2. Power and control conductors routed in common raceways may be spliced in common junction boxes.
   3. Install NEMA 4X junction and terminal boxes in wet and outdoor locations. Clearly label junction and terminal boxes containing splices with the word "SPLICE."
   4. Leave sufficient slack at junction boxes and termination boxes to make proper splices and connections. Do not pull splices into conduits.

C. Properly coat wires and cables with pulling compound before pulling into conduits and prevent mechanical damage to conductors during installation.

3.02 600-VOLT CLASS CABLE

A. Size power conductors in accordance with National Electrical Code when sizes are not indicated on the Drawings.

B. Install minimum Number 12 AWG wiring for power circuits unless otherwise specified or indicated on the Drawings, and minimum Number 14 AWG for control wiring unless otherwise specified.

C. Install minimum 14 AWG for internal panel control wiring with type MTW or SIS insulation.

D. Do not exceed cable manufacturer's pulling tension and side-wall pressures.

E. Terminations and Splices (600 Volt or Less):
   1. Terminations: Terminate control and instrument conductors in terminal boxes in accordance with Section 16134.
   2. Splicing: Join conductors mechanically with splice connectors and install heat-shrink type insulation. Splice conductors in accordance with manufacturer's instructions. Make waterproof heat shrink type splices in wet and below grade locations.
   3. Splice or weld grounding conductors of different sizes.
   4. Conductor Number 10 AWG and smaller for lighting and receptacle circuits may be spliced in junction boxes with wire nuts.

F. All conductors of size No. 1/0 AWG and smaller for installation in cable trays and continuing without splices via other conduits shall be of the multi-conductor type with overall jacket.

3.03 INSTRUMENTATION CLASS CABLE

A. Install instrumentation class cables in separate raceway systems.
   1. Install instrument cable in metallic conduit within non-dedicated manholes or pull boxes.
   2. Install cable without splices between instruments or between field devices and instrument enclosures or panels.

B. Do not make intermediate terminations.

C. Ground cable shields at only one location, typically at panels, not at field instruments.

3.04 FIELD QUALITY CONTROL

A. Testing: As specified in Section 16950.

3.05 FIELD CONDITIONS AND RELATED REQUIREMENTS

A. CONTRACTOR shall include necessary cost to clean all underground ductbanks and pull boxes prior to installation of required new conductors.

END OF SECTION

SECTION 16133

CONDUITS

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Galvanized rigid steel conduit,
   2. Flexible conduit,
   3. Polyvinyl chloride-coated rigid steel conduit, and
   4. Rigid nonmetallic polyvinyl chloride conduit.

B. Related Sections:
   1. Section 16050 - Basic Electrical Materials and Methods.

1.02 REFERENCES

A. American National Standards Institute (ANSI):
   1. C80.1 - Rigid Steel Conduit, Zinc Coated.

B. Electrical Manufacturers Association (NEMA):
   1. RN-1 - Polyvinyl Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit.

C. National Electrical Code (NEC):
   1. Table 300.5 - Minimum Cover Requirements (0 to 600 volts, Nominal).

D. Underwriters' Laboratories, Inc (UL):
   1. UL 6 - Rigid Metal Conduit.

1.03 SUBMITTALS

A. Product Data.

PART 2 PRODUCTS

2.01 CONDUIT

A. Galvanized Rigid Steel Conduit:
   1. Domestic raw steel, made smooth, clean, and free of burrs and rough spots to enhance wire pulling; interior and exterior surfaces coated with solid, unbroken layer of zinc; threads hot dip galvanized after cutting; entire surface finish coated with secondary bichromate treatment applied over galvanizing able to extend surface protection and prevent oxidation; threads protected by color coded end caps to provide quick trade size identification.

2. Manufacturers: One of the following or equal:
   a. LTV Steel Tubular Products Company, Galvite.
   b. Triangle PWC, Inc.
   c. Allied Tube and Conduit Corporation.

B. Liquid-Tight Flexible Conduit: Grounding type, weatherproof, watertight, maximum 60-inch lengths.
1. Manufacturers: One of the following or equal:
   a. American Brass Company.
   b. General Electric.
2. Flexible Metal Conduit: Aluminum with minimum trade size of 1/2 inch, maximum length allowed 60 inches.
3. Manufacturers: One of the following or equal:
   a. ALFLEX
   b. Allied Tube and Conduit Corporation.

C. Polyvinyl Chloride-Coated Rigid Steel Conduit:
1. Galvanized rigid steel conduit with coating conforming to ANSI C80.1 and UL 6; bendable without damage to coatings.
2. Manufacturers: One of the following or equal:
   a. Perma Kote by Robroy Industries.
   b. OCAL, Inc.

D. Rigid Nonmetallic Polyvinyl Chloride Conduit:
1. High density, Schedule 40, 90 degrees C, heavy-duty polyvinyl chloride, made from virgin polyvinyl chloride compound; maximum 6 grams per 100 grams smoke emission.
2. Manufacturers: One of the following or equal:
   a. Carlon.
   b. Triangle Conduit and Cable.

2.02 RELATED MATERIALS

A. Couplings, Connectors, and Fittings:
1. Threaded.
2. Manufactured with same materials and process as corresponding conduit.
3. Couplings for transitioning from liquid-tight conduit to PVC-coated rigid conduit shall be PVC-coated.

B. Condulet Fittings:
1. With wedge nut covers, weathertight when located outdoors or in wet or corrosive locations indicated on the Drawings, matching type for corresponding conduit systems.
2. Manufacturers: One of the following or equal:
   a. Crouse-Hinds.
   b. Appleton.

C. Galvanized Rigid Steel Conduit Expansion Fittings for Exposed Locations:
1. Manufacturers: One of the following or equal:
   a. OZ/Gedney, Type AX with jumper.
   b. Appleton, Type XJ with jumper.

D. Galvanized Rigid Steel Conduit Expansion Fittings at Structural Expansion Joints:
   1. Manufacturers: One of the following or equal:
      a. Spring City, Type D.
      b. Crouse-Hinds, Type D.

E. Conduit Seals:
   1. Manufacturers: One of the following or equal:
      a. Appleton.
      b. Crouse-Hinds.

F. Polyvinyl Chloride-Coated Rigid Steel Conduit Couplings: One provided loose with each length of conduit.

G. Fasteners for Polyvinyl Chloride-Coated Rigid Steel Conduit: Polyvinyl chloride-coated steel fasteners with Type 316 stainless steel bolts, nuts, and hardware.

H. Fasteners for Galvanized Rigid Steel Conduit: Galvanized steel fasteners with Type 316 stainless steel bolts, nuts, and hardware.

I. Conduit Mounting Strut:
   1. Type 316 stainless steel for mounting of polyvinyl chloride-coated rigid steel conduit.
   2. Hot-dip galvanized for other conduit types.

J. Conduit Thruwall Seals:
   1. Hot-dip galvanize.
   2. Polyvinyl chloride oversize sleeve.
   3. Manufacturers: One of the following or equal:
      a. O-Z/Gedney, Type "WSK."

2.03 POLYVINYL CHLORIDE-COATED RIGID STEEL CONDUIT FABRICATION

A. Coat rigid steel conduit, conduit fittings, and hangers with polyvinyl chloride.

B. Conduit:
   1. Surfaces, including galvanizing, are to remain intact and undisturbed on both inside and outside of conduit throughout preparation and application processing.
   2. Bond polyvinyl chloride coating to outer surfaces of conduit except threads.
   3. Provide bond between polyvinyl chloride coating and conduit surface that is greater than tensile strength of plastic.
   4. Provide minimum 40-mil thick coating on conduit.
   5. Coat interior of conduit and condulet fittings with nominal 2-mil thick corrosion-resistant urethane finish.
   6. Coat threads with clear urethane finish.

C. Couplings:
   1. Bond polyvinyl chloride coating to outer surfaces of couplings.
   2. Extend polyvinyl chloride sleeve equal to outside diameter of uncoated conduit beyond both ends of coupling approximately 1 pipe diameter or 1-1/2 inches, whichever is smaller.
   3. Provide minimum 40-mil thick coatings on couplings and sleeves.
   4. Bond polyvinyl chloride coating to outer surface of conduit bodies and fittings.

5. Extend polyvinyl chloride sleeves from hubs.
6. Provide same coating thickness on conduit bodies, fittings, and sleeve walls as on couplings in length and thickness.
7. Coat covers on conduit bodies on both sides so covers are completely interchangeable.
8. Coat interior of conduit couplings, sleeves, and conduit bodies with corrosion-resistant urethane finish.

D. The inside of conduit bodies are to remain undisturbed during processing and retain manufacturer's finish.

E. Polyvinyl Chloride-Coated, Mounting Hardware, and Associated Fittings:
1. All mounting hardware and associated fittings shall be polyvinyl chloride-coated in accordance with the intent of reference NEMA RN-1.
2. The polyvinyl chloride exterior coating shall have a normal thickness of 40 mils (.040 inch) except where part configuration or application otherwise dictate.
3. All fasteners for polyvinyl chloride-coated fittings and mounting hardware shall be of the Type 316 stainless steel.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install conduit runs in accordance with schematic representation as indicated on the Drawings and as specified. Modify conduit runs to suit field conditions, as accepted by the ENGINEER.

B. Install conduit runs for lighting and receptacle circuits, whether or not indicated on the Drawings, for circuit numbers indicated on the Drawings.

C. Install straight and true conduit runs with uniform and symmetrical elbows, offsets, and bends. Make changes in direction with long radius bends or with condulet fittings.

D. Install conduit runs so that runs do not interfere with proper and safe operation of equipment and not block or interfere with ingress or egress, including equipment removal hatches.

E. Expose conduit runs in buildings and structures, unless otherwise indicated on the Drawings.

F. Securely fasten exposed conduits with clamps or straps. Run exposed conduit on walls and ceilings only, parallel to planes of walls or ceilings. Do not run conduit diagonally. Securely fasten exposed polyvinyl chloride-coated rigid steel conduits with Type 316 stainless steel clamps or straps.

G. Use flexible conduit for short lengths required to facilitate connections between rigid conduit and motors, vibrating equipment, or control equipment, maximum length of 18 inches.

H. Support conduit runs on water-bearing walls 1 inch away from wall on an accepted channel. Use hot-dip galvanized steel or stainless steel channels, consistent with type of conduit being installed. Do not run conduit in water-bearing walls unless otherwise indicated on the Drawings.

I. Thoroughly ream conduit after threads have been cut to remove burrs. Seal joints with accepted conductive sealant compound and make watertight. Set up joints tight. Use bushings or conduit fittings at conduit terminations.

J. Install runs between pull boxes or junction boxes with total bends equaling not more than 270 degrees. Install NEC required pull boxes at locations acceptable to the ENGINEER. Plug conduits brought into pull boxes, manholes, handholes, and other openings until used to prevent entrance of moisture. Cap spare conduits and provide plastic pulling tape below threaded cap. Provide bonding bushing and bond wire.

K. Provide appropriate hangers, supports, fasteners, and seismic restraints to suit applications.

L. Existing conduit runs are to be cleaned and not crushed or creased. Verify internal dimensions of existing conduit prior to installation of conductors. Verify that no foreign objects or obstructions are present in conduit prior to installing conductors.

M. Install conduit system to provide firm mechanical assemblies with electrical conductivity throughout.

N. Install conduits complete between outlets, boxes, and circuit source before conductors are installed.

O. Install conduit thruwall seals where indicated on the Drawings.

3.02 POLYVINYL CHLORIDE-COATED RIGID STEEL

A. Attach cover to conduit body with Type 316 stainless steel screws.

B. Where patching is required, apply 40-mil thick polyvinyl chloride coating in accordance with manufacturer's instructions.

C. Polyvinyl chloride-coated conduit may be buried in earth without concrete encasement where indicated on the Drawings.

3.03 RIGID NONMETALLIC POLYVINYL CHLORIDE

A. Reinforce encasement as indicated on the Drawings. Install conduit supports at 30-inch intervals.

3.04 SCHEDULES

A. Conduit Sizes: In accordance with NEC, unless otherwise indicated on the Drawings or specified as follows:
   1. Concealed conduit in partitions or accessible ceilings: Minimum 3/4 inch.
   2. Exposed Conduit: Minimum 3/4 inch.
   3. Rigid Steel Encased In Concrete: Minimum 1 inch.

4. Rigid Non-Metallic Polyvinyl Chloride Encased In Concrete: Minimum 2 inches.
5. Direct Buried Conduit Size: Minimum 2 inches.

B. Conduit Uses and Applications:
   1. Rigid Steel Conduit: Typical, exposed conduit runs in dry and non-corrosive locations, unless otherwise noted.
   2. Liquid Tight Flexible Conduit: Final motor and instrument connection in non-hazardous areas.
   3. Polyvinyl Chloride-Coated Rigid Steel Conduit:
      a. Entering or exiting concrete including minimum 12 inches above and below grade or finished floor.
      b. In corrosive NEMA 4X designated areas.
      c. In exposed outdoor locations.
   4. Rigid Nonmetallic Polyvinyl Chloride Conduit: Runs concealed or concrete encased in walls, floors, and underground duct banks.

3.05 RACEWAYS IDENTIFICATION

A. Each new conduit, new wireway, and new boxes shall be identified by a specific number. The numbering system shall be in accordance with identification named on the Drawings or the process equipment identification. Products for identification of raceways are specified in Section 16075.

END OF SECTION

SECTION 16134

BOXES

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Outlet boxes, device boxes, metallic pull boxes, junction boxes, termination boxes.
   2. Concrete pull boxes.
   3. Fasteners used with wiring devices.
   4. Precast ground well boxes.

B. Related Sections:
   1. Section 16050 - Basic Electrical Materials and Methods.

1.02 REFERENCES

A. American National Standards Institute/National Electrical Manufacturers Association (ANSI/NEMA):
   1. OS1 - Sheet-Steel Outlet Boxes, Device Boxes, Covers, and Box Supports.
   2. OS2 - Nonmetallic Outlet Boxes, Device Boxes, Covers, and Box Supports.

B. National Electrical Code (NEC):
   1. Article 314 - Outlet, Device, Pull and Junction Boxes, Conduit Bodies, and Fittings.

C. National Electrical Manufacturers Association (NEMA):
   1. NEMA FB1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit and Cable Assemblies.
   2. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).

1.03 SUBMITTALS

A. Product Data.

B. Shop Drawings: Include identification and sizes of pull boxes for ENGINEER's acceptance prior to fabrication and installation.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Device Boxes, Metallic Pull Boxes, and Junction Boxes: One of the following or equal:
   1. Crouse-Hinds.
   2. Appleton.
   3. O-Z/Gedney.

4. Hoffman.

B. Precast ground well boxes: Minimum 12-inch inside diameter.
   1. Manufacturers: One of the following or equal:
      a. Brooks Products, Inc., valve boxes.
      b. Christy, valve boxes.

2.02 DEVICE BOXES AND JUNCTION BOXES

A. Materials: Heavy-duty rigid steel or rigid copper free aluminum, compatible with the location and conduit system being used, unless otherwise specified or indicated on the Drawings.

B. For Indoor or Non-Corrosive Areas: Provide cast FD type device boxes with epoxy finish, and compatible with the location and conduit system being used.

C. For Outdoor Locations, Corrosive Areas, or Wet Process Locations: Provide cast FD type boxes with PVC coating for outdoor locations, corrosive areas, and wet process locations compatible with the location and conduit system being used.

D. Coverplates:
   1. Indoor: Provide lighting switch and receptacle boxes of Type 302 stainless steel cover plates with cover gaskets, except where otherwise specified or indicated on the Drawings. Provide other boxes with Type 304 stainless steel cover screws and with cover gaskets.
   2. Outdoor and Corrosion Resistant: Provide lighting switch and receptacle boxes, weatherproof with yellow fiberglass lift cover plates with cover gaskets.

2.03 METALLIC PULL BOXES

A. Boxes for Applications in Dry and Non-Corrosive Location:
   1. Fabricated from 11 gauge (minimum) steel, completely weatherproof with gasketed removable covers; compatible with type of conduit systems being used; manufactured, furnished, and installed complete with grounding lug.

B. Boxes for Applications in Wet Areas, Outdoor Locations, and NEMA 4X Designated Areas: Fabricated from 14 gauge, 316 stainless steel, with gasketed covers and labeled NEMA 4X.

2.04 FASTENERS

A. Electroplated or stainless steel in boxes with wiring devices.

B. Screws, Nuts, Bolts, and Other Threaded Fasteners: Stainless Steel.

PART 3 EXECUTION

3.01 INSTALLATION

A. General: Comply with the National Electrical Code.

B. Terminal blocks installed in junction/terminal boxes as specified in Section 16050.

C. Provide weatherproof conduit hubs for all conduit connections to metallic pull boxes.

D. Phosphatize and prime with rust-resistant paint metallic pull box surfaces. Finish shall be 2 coats of ANSI 61 gray enamel paint.

E. Size pull boxes to meet National Electrical Code requirements and to provide sufficient room for the future conduits and cables indicated on the Drawings.

F. Furnish and install pull boxes as indicated on the Drawings and as specified. Install additional pull boxes as required to meet cable manufacturer's pulling tension requirements.

G. Install pull boxes such that access to them is not restricted by obstructions such as pipes, valves, ladders.

H. Secure metallic pull box covers with Type 316 stainless steel screws or bolts with coated threads.

I. Provide adequate supporting pillar(s) for boxes to be located above ground or above decks, where there is no structural wall or surface for box mounting.

END OF SECTION

SECTION 16135

CABINETS AND ENCLOSURES

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Cabinets and enclosures to house electrical controls, instruments, terminal blocks, and similar equipment.

B. Related Sections:
   1. Section 16010 - Electrical Requirements.

1.02 REFERENCES

A. National Electrical Code (NEC).

B. National Electrical Manufacturers' Association (NEMA).

1.03 SYSTEM DESCRIPTION

A. Design Requirements:
   1. Unless otherwise specified or indicated on the Drawings, enclosures to house electrical controls, instruments, terminal blocks, and similar equipment shall be NEMA 12 for indoor, dry, and non-corrosive locations, and NEMA 4X for outdoor installations, wet locations, and corrosive designated areas, and shall be compatible with the conduit system being used.
   2. Specific control panel enclosures shall be as indicated on the Drawings.

1.04 SUBMITTALS

A. Submit product data.

1.05 WARRANTY

A. Submit manufacturer's standard warranty.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. NEMA 12 Steel Enclosures: One of the following or equal:
   1. Hoffman Engineering Company.
   2. Rittal.

B. NEMA 4X Stainless Steel Enclosures: One of the following or equal:
   1. Hoffman Engineering Company.
   2. Henessy Products Inc.

2.02 FABRICATION

A. NEMA 12 Steel Enclosures:
   1. Fabricate enclosures from 14 gauge steel with continuous welded seams.
   2. Doors: Doors shall have full length piano hinges with the door removable by pulling the hinge pin.
   3. Provide a rolled lip around 3 sides of the door and around all sides of the enclosure opening.
   4. Gaskets: Attach gasket with oil-resistant adhesive and hold it in place with steel retaining strips.
   5. Provide hasp and staple for padlocking.
   6. Provide a print pocket for each enclosure.

B. NEMA 4X Stainless Steel Enclosures:
   1. Provide enclosures that consist of base and cover which shall be of Type 316 stainless steel with minimum thickness of 14 gauge. The enclosures shall be provided with cover hinges to form a weathertight seal between the cabinet and door.

2.03 FINISHES

A. Steel Enclosures:
   1. Do not paint NEMA 4X enclosures. Door fronts shall be ground smooth.
      a. Print pockets and interior panels shall be steel with a white enamel finish.
   2. Provide NEMA 12 enclosures with white enamel interior finish: The finish shall be light gray enamel, ANSI 61 exterior, over phosphatized surfaces. Panels shall be white enamel.

B. Other portions of these Contract Documents shall be checked for special conditions.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install Products in accordance with manufacturer's instructions.

B. Install enclosures and boxes plumb. Anchor securely to wall and structural supports at each corner. Install in accordance with Section 16050.

C. Install cabinet fronts plumb.

D. Provide size of pull boxes to meet National Electric Code requirements and ample space for conductors and devices.

E. Provide adequate supports and anchors to resist seismic forces.

F. Provide adequate supporting pillar(s) for cabinets to be located above decks, above slabs, or where there are no structural wall or surface for cabinet mounting.

END OF SECTION

SECTION 16140

WIRING DEVICES

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes: Wiring devices including the following:
   1. Snap switches and toggle switches.
   2. Plugs and receptacles.
   3. Control and pushbutton stations.
   4. Pilot devices.

1.02 SUBMITTALS

A. Product Data.

1.03 QUALITY ASSURANCE

A. Provide industrial grade products for wiring devices. Commercial grade products are not acceptable, unless otherwise specified or indicated on the Drawings.

1.04 WARRANTY

A. Submit manufacturer's standard warranty.

PART 2 PRODUCTS

2.01 SNAP OR TOGGLE SWITCHES

A. Manufacturers: One of the following or equal:
   1. Hubbell.
   2. General Electric.
   3. Leviton.
   4. Bryant.

B. Number of Poles: As indicated on the Drawings.

C. Rating: 20 amperes, 125 volt.

D. Special Switches and Covers: As specified or indicated on the Drawings.

2.02 120 VOLT RECEPTACLES

A. Manufacturers: One of the following or equal:
   1. Hubbell.
   2. General Electric.
   3. Leviton.
   4. Bryant.

B. Duplex Receptacles: 2-pole, 3-wire, grounded, 125 volts, industrial, rated at 20 amperes.
   1. Special Receptacles and Covers: As specified in Section 16134 or as indicated on the Drawings.

C. Ground Fault Interrupter Receptacles (GFI): Rated at 20 amperes at 125 volts alternating current.

2.03 LOCAL PUSHBUTTON MOTOR CONTROL STATIONS

A. Manufacturers: One of the following or equal:
   1. Furnas Electric Company.
   2. Square D Company.
   3. Allen-Bradley.
   4. Siemens.
   5. Cutler-Hammer.
   6. General Electric.

B. Types: Heavy duty, oiltight/watertight.

C. Components: Selector switches, pilot light, and pushbuttons.

D. Enclosures: As follows, unless otherwise indicated on the Drawings or specified:
   1. For Nonhazardous Indoor Locations: NEMA 12.
   2. For Outdoor Locations: NEMA 4X.

E. Field Located Maintained Pushbuttons: Red mushroom head, push-to-stop, pull-to-reset, with maintained contacts.

2.04 PILOT DEVICES

A. Manufacturers: One of the following or equal:
   1. Furnas Electric Company.
   2. Square D Company.
   3. Allen-Bradley.
   4. Siemens.
   5. Cutler-Hammer.
   6. General Electric.

B. Type: Heavy-duty, suitable for mounting in control stations, control panels, and other electrical equipment.

C. Components: Oiltight/watertight pushbuttons, selector switches, pilot light, and incidental items.

D. Casting: Durable 1 piece with chrome plated octagonal mounting nuts.

E. Pushbuttons: Heavy-duty plastic.

F. Pilot Light Lenses: Shatter resistant plastic, push-to-test.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install wiring devices in accordance with manufacturer's instructions.

B. Mount wiring devices as indicated on the Drawings.

3.02 LOCAL PUSHBUTTON MOTOR CONTROL STATION INSTALLATION

A. Install Start-Lockout-Stop pushbutton control stations adjacent to every motor unless otherwise indicated on the Drawings.

3.03 PROTECTION

A. Protect products until acceptance by OWNER.

END OF SECTION

SECTION 16222

MOTORS

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes: Single phase motors, direct current motors, and 3-phase motors up to and including 200 horsepower.

1.02 REFERENCES

A. American Bearing Manufacturers Association (ABMA):
   1. ABMA 9 - Load Ratings and Fatigue Life for Ball Bearings.
   2. ABMA 11 - Load Ratings and Fatigue Life for Roller Bearings.

B. Institute of Electrical and Electronic Engineers (IEEE).

C. National Electrical Manufacturers' Association (NEMA):
   1. MG-1 - Motors and Generators.

1.03 DEFINITIONS

A. Solid-State Motor Controller: Includes variable frequency drives and solid-state reduced voltage starters.

B. Nominal Efficiency: The average full load efficiency value of a large population of the manufacturer's motors of the same design.

C. Minimum Efficiency: The minimum full load efficiency value of any individual motor associated with the nominal motor efficiency.

1.04 SUBMITTALS

A. Product Data:
   1. Descriptive bulletins.
   2. Outline Drawings with dimensions.
   3. Cut-away and exploded view Drawings.
   4. Parts list with material designations.
   5. Nameplate data.
   6. Motor weight, frame size, and conduit box location.
   7. Description of insulation system.

B. Design and Performance Data:
   1. Bearing design and bearing life calculations.
   2. Performance data required by Schedule A, nameplate data, and following information:
      a. Service factor.
      b. Efficiency at 1/2 and 3/4 load.
      c. Power factor at 1/2 and 3/4 load.

d. When required for power factor improvement, capacitor size in KVAR with calculation data for motors sized 50 horsepower and above.

3. Special features including condensation heaters and winding temperature detectors.
4. Performance data for motors with synchronous speed of 900 revolutions per minute and below.
5. Factory test reports with test reference standard identified.

1.05 QUALITY ASSURANCE

A. Certification:
   1. When motors are driven by variable speed drive systems, submit certification that selected motor:
      a. Is capable of satisfactory performance under the intended load.
      b. Is suitable for operation with the proposed variable speed drive unit.
      c. Is an inverter duty motor.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Motors: One of the following or equal:
   1. U. S. Motors.
   2. General Electric.
   3. Reliance.

2.02 ELECTRICAL MOTORS

A. General:
   1. Manufactured with cast iron frames in accordance with NEMA MG 1, and in accordance with specified requirements.
   2. Alternating Current Motors: Squirrel cage induction type suitable for 60 hertz power.
   3. Where not otherwise specified or indicated on the Drawings:
      a. Motors 1 Horsepower and Larger: 3-phase, 460 volt.
      b. Motors less than 1 Horsepower: Single phase, 120 volt.
   4. 2-Speed Motors: Dual winding design.
   5. Temperature Rating and Altitude Requirements: Where not otherwise specified or indicated on the Drawings, provide motors that are rated suitable for continuous operation in 50 degree Celsius ambient temperature at project site altitude.
      a. Temperature Rise Under Full Load: Not to exceed that for Class B insulation (80 degrees Celsius).
   6. Motor Data: Specific motor data including horsepower, speed, and enclosure type are indicated on the Drawings and specified under equipment for which motor is required.
   7. Torque and Power of Motors:
      a. Provide motors that develop sufficient torque for required service throughout acceleration range at voltage 10 percent less than motor nameplate rating.
      b. Provide motors that develop sufficient torque when started using reduced voltage starters.

8. Motor Leads and Insulating Material: Insulated leads with non-wicking, non-hydroscopic material. Class F insulation.
9. Grounding Lugs: Provide inside conduit boxes for motor frame grounding.
10. Hardware: Type 316 stainless steel.

B. Provide motors that are special premium efficiency type.
1. Provide premium efficiency type motors having nominal full load efficiencies and power factors as specified in Schedule A appended to this Section.
2. Actual full load efficiency of individual motors within the nominal efficiency band shall not be less than the minimum efficiency value specified in Schedule A.

C. Condensation Heaters:
1. Use: Required in motors in outdoor applications.
2. Type: Cartridge or flexible wrap-around type installed within motor enclosure adjacent to core iron.
3. Rating, Phase and Wattage: Rated for 120 volt, single phase with wattage as required.
4. Bring power leads for heaters into conduit box.

2.03 SINGLE PHASE MOTORS

A. Capacitor start type rated for operation at 115 volts, 60 hertz, unless otherwise specified or indicated on the Drawings.

B. Totally enclosed, fan cooled motors manufactured in accordance with NEMA MG 1-10.35.

C. Ball Bearings: Sealed.

D. 1/2 Horsepower or Less Fan Motors:
1. Split-phase or shaded pole type when standard for the equipment.
2. Open type when suitably protected from moisture, dripping water, and lint accumulation.

E. Wound rotor or commutator type single-phase motors only when their specific characteristics are necessary for application and their use is acceptable to the ENGINEER.

2.04 DIRECT CURRENT MOTORS

A. Designed to operate from 125 volts direct current, unless otherwise noted on the Drawings.

B. Sealed ball bearings having ABMA B-10 life of 60,000 hours or more.

C. Insulation System: NEMA 1-1.65, Class F, resistant to attack by moisture, acids, alkalies, and mechanical or thermal shock.

D. Totally enclosed fan cooled enclosures.

2.05 3-PHASE MOTORS

A. Suitable for 460 volt 3-phase power unless otherwise specified or indicated on the Drawings.

B. NEMA Design B except where driven load characteristics require other than normal starting torque.
   1. Starting kilovolt ampere per horsepower (locked rotor) are not to exceed values specified in NEMA MG-1-10.37.

C. Motor Bearings: Antifriction, regreasable, and filled initially with grease suitable for ambient temperatures to 50 degrees Celsius.
   1. Suitable for intended application and have ABMA B-10 rating life of 60,000 hours or more.
   2. Fit bearings with easily accessible grease supply, flush, drain, and relief fittings using extension tubes where necessary.
   3. Provide two pole motors with sleeve type bearings.

D. Insulation Systems:
   1. Comply with NEMA 1-1.65.
   2. Class F system with Class B temperature rise.
   3. Resistant to attack by moisture, acids, alkalies, and mechanical or thermal shock.

E. Conduit Boxes: Cast iron or stamped steel, split from top to bottom and capable of being rotated to 4 positions.
   1. Provide gaskets between following:
      a. Frames and conduit boxes.
      b. Conduit boxes and box covers.

F. Motor Enclosures: When enclosure type is not specified in individual equipment Specifications, provide a Totally Enclosed Fan Cooled (TEFC) enclosure for non-hazardous (unclassified) areas and explosion-proof enclosure for hazardous (classified) areas:
   1. Totally Enclosed Fan Cooled: Cast iron conduit box; 1.15 service factor at 50 degrees Celsius ambient; tapped drain holes with Type 316 stainless steel plugs for frames 286T and smaller, and automatic breather and drain devices for frames 324T and larger; upgraded insulation by minimum of 3 dips and bakes and sealer coat of epoxy or silicone.
   2. Explosion-Proof: 1.15 service factor at 50 degrees Celsius; tapped drain holes with corrosion resistant plugs for frames 286T and smaller and automatic breather and drain devices for frames 324T and larger; UL label for Class I, Division 1, Group D hazardous area.
   3. For special application such as corrosive environment, use a Severe Duty motor. Corrosion resistant type conforming to motors designated by manufacturer as "Chemical Duty," "Mill and Chemical," "Custom Severe Duty," or similar applicable manufacturer's quality designation with 1.15 service factor at 50 degrees Celsius; tapped drain holes with Type 316 stainless steel plugs for frames 286T and smaller, and automatic breather and drain devices for frames 324T and larger; epoxy finish; and upgraded insulation using encapsulated or dip and bake windings.

4. Submersible: Watertight casing with insulated windings which are moisture resistant.
    a. Pump Motors Specified to be Submersible: Provide motors having cooling characteristics suitable for continuous operation in totally, partially, or nonsubmerged condition without overheating or other damage.
    b. Electrical Cables: Provide cables of adequate length to allow unit to be wired without splices.
5. Open Drip-Proof where specified elsewhere: Stamped steel conduit boxes; 1.15 service factor at 50 degrees Celsius.

2.06 MOTOR SIZES

A. Motor sizes specified in the Specifications and indicated on the Drawings are minimum sizes.

B. Provide motors, electrical circuits, and equipment of ample horsepower capacity to operate equipment without exceeding rated nameplate horsepower, full-load current at rated nameplate voltage, or overheating at maximum load capacity.

2.07 SOURCE QUALITY CONTROL

A. Factory Testing of 3-Phase Motors:
    1. When specified in individual equipment Specifications, factory test motors. Include testing of:
        a. No load current.
        b. Locked rotor current.
        c. Winding resistance.
        d. High potential.
    2. Perform in accordance with applicable NEMA Standards.
    3. Furnish copies of test reports.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install motors in accordance with manufacturer's instructions.

3.02 SCHEDULES

A. Schedule A: Full load motor efficiency and power factor rating requirements for premium efficiency, 460 volt, 3-phase horizontal motors.

SCHEDULE A

FULL LOAD MOTOR EFFICIENCY AND POWER FACTOR RATING REQUIREMENTS FOR PREMIUM EFFICIENCY, 460 VOLT, 3 PHASE HORIZONTAL AND VERTICAL MOTORS

		Protected (Open Drip Proof)[1]			Totally Enclosed Fan Cooled[1]		
Nominal Horsepower (Horsepower)	Syn. (revolutions per minute)	Minimum Efficiency (Percent)	Nominal Efficiency (Percent)	Power Factor (Percent)	Minimum Efficiency (Percent)	Nominal Efficiency (Percent)	Power Factor (Percent)
1	1,800	81.5	84.0	70.9	81.5	84.0	77.7
	1,200	78.5	81.5	57.0	78.5	81.5	57.0
1-1/2	3,600	81.5	84.0	86.0	81.5	84.0	86.0
	1,800	81.5	84.0	73.0	81.5	84.0	77.4
	1,200	81.5	84.0	67.8	84.0	86.5	67.8
2	3,600	81.5	84.0	87.7	84.0	86.5	87.7
	1,800	81.5	84.0	76.7	81.5	84.0	78.8
	1,200	84.0	86.5	68.1	85.5	87.5	68.1
3	3,600	80.0	82.5	90.4	84.0	86.5	82.8
	1,800	86.5	88.5	78.9	86.5	88.5	79.2
	1,200	87.5	89.5	71.0	87.5	89.5	71.0
5	3,600	86.5	81.5	84.5	86.5	88.5	87.0
	1,800	87.5	88.5	80.4	86.5	88.5	81.0
	1,200	88.5	89.5	73.0	87.5	89.5	74.4
	900	87.5	87.5	70.0	87.5	89.5	70.5
7-1/2	3,600	86.5	88.5	86.7	87.5	89.5	86.3
	1,800	87.5	89.5	83.3	88.5	90.2	84.4
	1,200	88.5	90.2	78.2	88.5	90.2	78.3
	900	87.5	89.5	72.0	87.5	89.5	72.0

SCHEDULE A

FULL LOAD MOTOR EFFICIENCY AND POWER FACTOR RATING REQUIREMENTS FOR PREMIUM EFFICIENCY, 460 VOLT, 3 PHASE HORIZONTAL AND VERTICAL MOTORS

		Protected (Open Drip Proof)[1]			Totally Enclosed Fan Cooled[1]		
Nominal Horsepower (Horsepower)	Syn. (revolutions per minute)	Minimum Efficiency (Percent)	Nominal Efficiency (Percent)	Power Factor (Percent)	Minimum Efficiency (Percent)	Nominal Efficiency (Percent)	Power Factor (Percent)
10	3,600	88.5	90.2	85.5	89.5	91.0	87.5
	1,800	88.5	90.2	82.8	88.5	90.2	86.0
	1,200	89.5	91.0	80.5	89.5	91.0	81.0
	900	89.5	91.0	75.8	88.5	90.2	76.0
15	3,600	88.5	90.2	86.7	89.5	91.0	87.4
	1,800	90.2	91.7	81.9	91.0	92.4	82.7
	1,200	89.5	91.0	81.7	90.2	91.7	78.9
	900	89.5	91.0	76.8	88.5	90.2	77.0
20	3,600	90.2	91.7	87.1	90.2	91.7	88.7
	1,800	91.0	92.4	83.1	91.0	92.4	84.2
	1,200	90.2	91.7	83.7	90.2	91.7	79.0
	900	90.2	91.7	77.2	89.5	91.0	77.2
25	3,600	90.2	91.7	88.1	91.0	92.4	85.5
	1,800	91.7	93.0	82.7	92.4	93.6	84.3
	1,200	91.0	92.4	79.2	91.0	92.4	83.5
	900	90.2	91.7	76.3	90.2	91.7	76.4
30	3,600	91.7	93.0	88.3	91.0	92.4	73.9
	1,800	91.7	93.0	83.3	92.4	93.6	83.1
	1,200	91.7	93.0	82.1	91.7	93.0	83.5
	900	91.7	93.0	76.0	91.0	92.4	76.5

SCHEDULE A

FULL LOAD MOTOR EFFICIENCY AND POWER FACTOR RATING REQUIREMENTS FOR PREMIUM EFFICIENCY, 460 VOLT, 3 PHASE HORIZONTAL AND VERTICAL MOTORS

		Protected (Open Drip Proof)[1]			Totally Enclosed Fan Cooled[1]		
Nominal Horsepower (Horsepower)	Syn. (revolutions per minute)	Minimum Efficiency (Percent)	Nominal Efficiency (Percent)	Power Factor (Percent)	Minimum Efficiency (Percent)	Nominal Efficiency (Percent)	Power Factor (Percent)
40	3,600	92.4	93.6	89.2	92.4	93.6	87.5
	1,800	93.0	94.1	80.8	93.0	94.1	82.3
	1,200	92.4	93.6	82.2	92.4	93.6	80.5
	900	91.7	93.0	75.0	91.7	93.0	75.5
50	3,600	91.7	93.0	86.3	91.7	93.0	87.7
	1,800	93.0	94.1	83.3	93.0	94.1	84.2
	1,200	92.4	93.6	83.0	92.4	93.6	80.6
	900	92.4	93.6	79.2	91.7	93.0	79.5
60	3,600	92.4	93.6	88.8	92.4	93.6	88.9
	1,800	94.1	95.0	84.5	94.1	95.0	84.2
	1,200	93.6	94.5	84.4	93.0	94.1	85.4
	900	92.4	93.6	78.8	91.7	93.0	79.3
75	3,600	93.6	94.5	87.5	93.6	94.5	89.7
	1,800	94.1	95.0	85.0	94.1	95.0	85.5
	1,200	94.1	95.0	85.0	94.1	95.0	85.0
	900	93.6	94.5	84.5	93.0	94.1	78.6
100	1,800	94.5	95.4	85.0	94.5	95.4	85.0
	1,200	94.1	95.0	85.0	94.1	95.0	81.3
	900	93.6	94.5	80.2	93.0	94.1	77.8

SCHEDULE A

FULL LOAD MOTOR EFFICIENCY AND POWER FACTOR RATING REQUIREMENTS FOR PREMIUM EFFICIENCY, 460 VOLT, 3 PHASE HORIZONTAL AND VERTICAL MOTORS

		Protected (Open Drip Proof)[1]			Totally Enclosed Fan Cooled[1]		
Nominal Horsepower (Horsepower)	Syn. (revolutions per minute)	Minimum Efficiency (Percent)	Nominal Efficiency (Percent)	Power Factor (Percent)	Minimum Efficiency (Percent)	Nominal Efficiency (Percent)	Power Factor (Percent)
125	1,800	94.5	95.4	86.9	94.5	95.4	88.5
	1,200	94.1	95.0	81.5	94.1	95.0	85.8
	900	94.1	95.0	--	93.6	94.5	80.4
150	1,800	95.0	95.8	86.4	95.0	95.8	86.3
	1,200	94.5	95.4	77.6	94.5	95.4	83.9
	900	94.1	95.0	--	93.6	94.5	79.7
200	1,800	95.0	95.8	84.6	95.0	95.8	87.5
	1,200	94.5	95.4	78.5	94.5	95.4	87.3
	900	94.5	95.4	--	94.1	95.0	80.0

NOTES:

(1) Motor data for continuous duty, NEMA Design B, 1.15 service factor, 40 degrees Celsius ambient, Class F insulation, 3 phase, 460 volt, at listed speed rating.

(2) Correct to 95 percent power factor and submit capacitor size in KVAR as specified in Article titled "Submittals."

(3) Totally enclosed fan cooled efficiencies apply to both horizontal and vertical motors.

END OF SECTION

SECTION 16480

MINI-POWER CENTER

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes: Combination transformer/panelboard units commonly referred to by manufacturer trademark as "Mini-Power-Center."

1.02 SUBMITTALS

A. Product Data: Provide catalog data on all components in accordance with this Specification. Also provide a panel schedule indicating each circuit breaker and all load descriptions, as indicated on the Drawings.

1.03 QUALITY ASSURANCE

A. Comply with the following Codes and Standards:
   1. NEMA (Testing Standards BU 1.3.03 or 1.3.04).
   2. UL listing and labeling for material.
   3. NFPA-70.

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Cutler-Hammer.

B. Square D Company.

2.02 MATERIALS

A. Mini-Power Center shall have kVA rating as indicated on the Drawings.

B. Transformer shall have 480 volt primary and 120/240 volt secondary as indicated.

C. Transformer shall have 2-5 percent primary traps below normal. Transformer to be encapsulated in a sand-epoxy resin to protect against moisture, rust and corrosive environments.

D. Enclosures shall be cleaned, phosphatized and electrostatically power coated and shall be UL listed for outdoor use. A padlockable hinged access door which maintains itself in the open position shall be provided.

E. Mini-Power Center unit shall include integrally mounted and wired primary and secondary main circuit breakers in accordance with NFPA 70 requirements. Main and all branch circuit breakers shall be bolt-on type.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install where indicated on the Drawings. Mount unit such that it is level and plumb.

B. Securely fasten to wall of building or equipment with 3/8-inch bolts and lockwashers.

C. Insert accurate panel schedule on inside of enclosure door. Label each wire with its associated branch circuit number.

D. Install nameplate on exterior of Mini-Power Center to indicate panel designation.

E. Attach transformer secondary grounded tap to system ground with copper grounding conductor as indicted on the Drawings.

F. Provide grounding in accordance with N.E.C. Article 250.

END OF SECTION

SECTION 16950

ELECTRICAL TESTING

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes: Acceptance testing of electrical system, wiring, equipment, and grounding.

1.02 REFERENCES

A. National Electrical Testing Association (NETA):
   1. ANSI NETA ATS-2009 – Standard for Acceptance Testing Specifications for Electric Power Equipment and Systems.

1.03 SUBMITTALS

A. Pre-Test Submittals:
   1. Testing service qualifications.
   2. Testing personnel qualifications (resumes).
   3. Equipment testing schedule.
   4. Test data forms.

B. Submit Equipment Testing Schedule no later than 7 days prior to scheduled date of testing..

C. Post-Test Submittals: Summary Test Report consists of the following:
   1. Summary of testing for the project.
   2. Description of the equipment tested.
   3. Description of the test and test procedures.
   4. Test results.
   5. Conclusions and recommendations.
   6. Completed test forms, including witness's signatures.
   7. List of test equipment and calibration documents.
   8. Date and time.
   9. Include the Following Data Tabulated for Each Piece of Equipment:
      a. Circuit number.
      b. Equipment or motor name and tag number (where applicable).
      c. Nameplate full-load-ampere rating.
      d. Motor service factor.
      e. Motor ambient temperature rating.
      f. Overload relay rating.
      g. Measured full load current.
      h. Measured discharge pressure (where applicable).
      i. Measured flow rate (where applicable).

D. Project Record Documents: Note or indicate wiring deviations from Contract Documents on Project Record Documents.

1.04 QUALITY ASSURANCE

A. Testing Firm Qualifications:
   1. Obtain the services of an independent testing service firm that meets the Federal OSHA criteria for accreditation of testing laboratories, Title 29, Part 1910.7 or has a work history and qualifications acceptable to ENGINEER.
   2. Prequalified Testing Services and Manufacturing Firms:
      a. General Electric Company.
      b. Cutler-Hammer.
      c. Square D Company Technical Service Divisions.
   3. Qualifications of other testing service firms may be submitted.
   4. Testing service or testing personnel may be accepted or rejected based upon, but not limited to, the testing equipment intended to be used, the qualifications of the firm, and personnel.

B. Test Equipment Traceability:
   1. Testing firm shall have a calibration program which maintains applicable test instrumentation and equipment within rated accuracy.
   2. Equipment and instruments used to evaluate electrical performance shall be calibrated to a secondary standard traceable to the National Institute of Standards and Technology.
   3. Test equipment operating instructions and procedures shall be with the test equipment.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that electrical work is free from improper grounds, short circuits, and overloads.

B. Verify correctness of wiring first by visual comparison of the conductor connections with connection diagrams.

C. Make individual circuit continuity checks by using electrical circuit testers.

D. Verify correctness of wiring by actual electrical operation of electrical and mechanical devices in both manual and automatic modes of operation.

3.02 ACCEPTANCE TESTING

A. Perform testing and allow OWNER to witness testing.

B. Perform electrical acceptance testing in accordance with NETA Standards.

C. Perform tests to assure that electrical equipment specified to be tested will operate within industry and manufacturer's published tolerances, and will perform safely. Record test result data, to be used as a baseline for future tests.

D. Install equipment with acceptable data. Equipment for which acceptable test data has not been submitted, or has been submitted but rejected, shall be deemed as not meeting Contract requirements.

E. Conduct 3 point fall of potential ground test by using equipment. Manufacturers: One of the following or equal:
   1. Biddle Company.
   2. Associated Research.

F. Test Project electrical equipment, including electrical distribution equipment and grounding. Complete test reports for each individual piece of equipment.

G. Test Project electrical equipment included on, but not limited to the following list:
   1. Two-Winding Transformer.
   2. Transformer Turns Ratio.
   3. Insulation Resistance.
   4. Ground Electrode Systems.
   5. Instrumentation Loop Testing as Described in DIVISION 17 of these Specifications.

3.03 SUMMARY TEST REPORT

A. Upon completion of testing in every area, submit summary test report.

END OF SECTION

SECTION 17050

PROCESS CONTROL AND INSTRUMENTATION SYSTEM GENERAL

PART 1 GENERAL

1.01 SUMMARY

A. This Section includes general requirements that apply to all process control and instrumentation systems for the entire project.

B. Related Sections:
   1. The Contract Documents are a single integrated document, and as such all DIVISIONs and Sections apply. It is the responsibility of the CONTRACTOR and its Subcontractors to review all Sections to provide a complete and coordinated project.
   2. Items involving electrical, control, and instrumentation construction may be shown on Drawings or referred to in Specifications that do not apply specifically to electrical, control and instrumentation systems.
   3. The Drawings and Specifications are complementary to each other; what is called for by one shall be as binding as if called for by both. If a conflict between Drawings and Specifications is discovered, this shall be referred to the ENGINEER as soon as possible for resolution.

C. Interfaces to Equipment, Instruments, and Other Components:
   1. The Contract Drawings, Specifications, and overall design are based on non-certified information furnished by various equipment manufacturers. This "equipment" includes, but is not limited to, instruments, control devices, and electrical equipment.
   2. The CONTRACTOR shall include all labor, material, and other costs in the bid to add additional instruments, wiring, computer inputs/outputs, controls, conduit, interlocks, electrical hardware, etc., into the Work based on the equipment manufacturer's final certified Drawings.
   3. Revise or produce new loop diagrams to meet the equipment manufacturer's wiring requirements.
   4. Such changes to instrumentation and electrical work shall be incorporated into the Work at no additional cost to the OWNER in light of the CONTRACTOR's knowledge that non-certified vendor information has been used in the design, and due to the fact that the final selection of the vendor may have been by the CONTRACTOR.
   5. All such changes and additions shall be submitted to the ENGINEER for acceptance before starting field installation work.

1.02 REFERENCES

A. Code Compliance:
   1. Without limiting the generality of other requirements of these Specifications, all work specified herein shall conform to or exceed the applicable requirements of the code and standard documents listed to the extent that the requirements

in them are not in conflict with the provisions of the Contract Documents and this Section. However, where such documents have been adopted as a code or ordinance by the public agency having jurisdiction, such code or ordinance shall take precedence.

2. All equipment, materials, installation, and other work shall conform to the following codes and standards:
   a. National Fire Protection Association (NFPA):
      1) NFPA 70 - National Electric Code (NEC) 2008.
      2) NFPA 496 - Purged and Pressurized Enclosures for Electrical Equipment, where applicable.
   b. Underwriters Laboratories, Inc. (UL):
      1) UL 508 - Industrial Control Equipment.
   c. International Building Code (IBC).
   d. The versions of the above documents that are current as of the Project bid opening date shall apply.
3. Where the requirements set forth in these Specifications or on the Drawings are greater or more rigid than the codes or standards referenced above, the applicable Specifications or Drawings shall govern.
4. In the case of conflict between any above-referenced codes or standards and the Specifications or Drawings, promptly notify ENGINEER in writing and request a clarification.

B. Compliance with Laws and Regulations:
   1. Nothing contained in these Specifications or shown on the Drawings shall be construed as to conflict with any national, state, municipal, or local laws or regulations governing the installation of work specified herein, and all such acts, ordinances, and regulations are hereby incorporated and made a part of these Specifications. All such requirements shall be satisfied by the CONTRACTOR at no additional expense to the OWNER.
   2. Should a conflict exist between the Contract Documents and an applicable law, ordinance, or regulation, it will be assumed that the more expensive method has been bid.
   3. If a conflict between the Contract Documents and an applicable law or regulation is discovered, promptly notify the ENGINEER in writing.

C. Standards:
   1. The standards listed are hereby incorporated into these Specifications. All work specified in DIVISION 17 shall conform to, or exceed, the applicable requirements of the referenced documents to the extent that the requirements in the listed standards are not in direct conflict with provisions of DIVISION 17. Where there is a clear, direct conflict between the listed standard and DIVISION 17 or the Instrumentation Drawings, promptly notify the ENGINEER in writing and request a clarification.
   2. The publications are referred to in the text by the basic designation only. The latest edition of referenced publications in effect at the time of the bid shall govern.
   3. American National Standards Institute (ANSI):
      a. ANSI B16.5 - Pipe Flanges and Flanged Fittings.
   4. American National Standards Institute/American Petroleum Institute (ANSI/API):
      a. API RP550 - Manual on Installation of Refinery Instruments and Control Systems.

b. ANSI/API 551-1992 - Process Measurement Instrumentation.

5. American Society of Testing and Materials (ASTM):
   a. ASTM A269 - Seamless and Welded Austentic Stainless Steel Tubing for General Service.
6. Instrumentation, Systems, and Automation Society (ISA):
   a. ISA S5.1 - Instrumentation Symbols and Identification.
   b. ISA S5.3 - Graphic Symbols for Distributed Control/Shared Display Instrumentation, Logic and Computer Systems.
   c. ISA S5.4 - Instrument Loop Diagrams.
   d. ISA S5.5 - Graphic Symbols for Process Displays.
   e. ISA RP7.1 - Pneumatic Control Circuit Pressure Test.
   f. ISA S7.3 - Quality Standard for Instrument Air.
   g. ISA S7.4 - Air Pressures for Pneumatic Controller and Transmission Systems.
   h. ISA S18.1 - Annunciator Sequences and Specifications.
   i. ISA S20 - Specification Forms for Process Measurement and Control Instruments, Primary Elements, and Control Valves.
   j. ISA S50.1 - Compatibility of Analog Signals for Electric Industrial Process Instruments.
   k. ISA S51.1 - Process Instrumentation Terminology.
   l. ISA RP60.3 - Human Engineering for Control Centers.
   m. ISA S71.04 - Environmental Conditions for Process Measurement and Control Systems: Airborne Contaminants.
7. Milspec:
   a. MMIL-I-46058C - Electrical Insulating Compound.
8. National Electrical Manufacturers Association (NEMA):
   a. NEMA 250 - Enclosures for Electrical Equipment (1,000 volts maximum).
   b. SAMA PMC-17 - Bushings and Wells for Temperature Sensing Elements.

1.03 DEFINITIONS

A. Where a term is used in the Contract Documents relating to instrumentation, and the meaning is not defined in the Contract Documents, the meaning of the term shall be as defined in ISA S51.1 Process Instrumentation Terminology, or if not contained in ISA 51.1, as defined in standards from the following:
   1. National Electrical Code.
   2. Institute of Electrical and Electronic Engineers.
   3. Instrumentation, Systems, and Automation Society.
   4. National Fire Protection Association.
   5. National Electrical Testing Association.

B. Additional Definitions:
   1. Control Circuit: Any circuit operating at 120 volts AC or DC or less, whose principal purpose is the conveyance of information (including performing logic) and not the conveyance of energy for the operation of an electrically powered device.
   2. Panel: An instrument support system that may be either a flat surface, a partial enclosure, or a complete enclosure for instruments and other devices used in process control systems. Unless otherwise specified or clearly indicated by the context, the term "panel" in these Contract Documents shall be interpreted as a general term, which includes flat panels, enclosures, cabinets and consoles.

3. Power Circuit: Any circuit operating at 100 volts (AC or DC) or more, whose principal purpose is the conveyance of energy for the operation of an electrically powered device.
4. Signal Circuit: Any circuit operating at less than 50 volts AC or DC.
5. Two-Wire Transmitter: A transmitter that derives its operating power supply from the signal transmission circuit and therefore requires no separate power supply connections. As used in this Specification, two-wire transmitter refers to a transmitter which provides 4 to 20 milliampere current regulation of a signal in a series circuit with an external 24 volt direct current driving potential and an external circuit resistance of 600 ohms, minimum.

C. Acronym Definitions:
1. CIS: Computer Interface System: The computer-based operator interface portion of a SCADA system that provides operator interface, data storage and retrieval, archiving, alarming, and reporting. Sometimes referred to as "MCS" or "CCS".
2. ICSC: Instrumentation and Control System Contractor.
3. I/O: Input / Output.
4. LCP: Local Control Panel containing operator interface devices, control devices, operators, etc. generally without a PLC.
5. P&ID: Process and Instrumentation Diagram.
6. PCIS: Process Control and Instrumentation System, which includes all of the work specified in DIVISION 17 and depicted on the "N" series Instrumentation Drawings.
7. PCM: Process Control Module: and enclosure containing any of the following devices: PLC, RIO, HMI, LOI.
8. PLC: Programmable Logic Controller.
9. RIO: Remote I/O device for the PLC which may be a remote I/O rack, or remote block I/O.
10. RTU: Remote Telemetry Unit.
11. SCADA: Supervisory Control and Data Acquisition system incorporating and including all parts of the PLCs, PCs, PCMs, RIOs, CIS, etc., except for those devices that are supplied as part of a CONTRACTOR-supplied packaged control system. CONTRACTOR-supplied packaged systems are supplied to the CONTRACTOR from vendors of packaged process, equipment, chemical, or filtration systems as describe in these Specifications, shown on the Drawings, or both. The PCIS therefore is comprised of the SCADA system and CONTRACTOR-supplied packaged control systems.
12. VCP: Vendor Control Panel furnished with particular equipment.

1.04 SYSTEM DESCRIPTION

A. General:
1. Furnish, install, and place into service additions to the existing Process Control and Instrumentation System (PCIS), to perform the specified monitoring, communications, alarm, control, display and reporting functions for the OWNER's facilities all in accordance with the requirements of the Contract Documents.
2. Provide detailed, complete, and thorough operations and maintenance documentation, including, but not limited to: operations manuals, maintenance manuals, as-built wiring Drawings, training manuals, as-built Vendor supplied

software documentation, and all other documentation required to operate, modify, and maintain all instrumentation provided and installed as part of this Project.

3. Portions of this project will be installed in existing facilities and interfaced to existing circuits, power systems, controls, and equipment. Perform comprehensive and detailed field investigations of existing conditions (circuits, power systems, controls, equipment, etc). Determine all information needed to document, interface with, modify, upgrade, or replace existing circuits, power systems, controls, and equipment.

B. Existing System:
   1. The existing system consists of the following:
      a. PLC-3 located within existing Electrical Building Electrical Room.
      b. PLC-4 located within existing Compliance Building Electrical Room.
   2. New control system modules shall be added to the existing PLCs as required and shall be utilized for input of signals as indicated on the Drawings.

C. New System:
   1. Programming:
      a. Programming modifications for the PCIS shall be performed by the CONTRACTOR.
      b. Coordinate requirements for documentation of programming modifications with the OWNER.

D. Retrofit:
   1. Retrofit and extension of existing plant shall be subject to special scheduling and sequencing as specified.
   2. According to individual circumstances and in compliance with the Drawings, conduit and cable connections shall be extended from existing locations or entirely replaced.
   3. The CONTRACTOR shall be responsible for the integrity and measurement accuracy of all loops. However, any defect found in existing equipment shall be the responsibility of the OWNER.
   4. The standards of documentation, instrument tagging, cable and conductor ferruling, terminal identification and labeling which apply to the new installation apply equally to the existing installation which forms part of the modified system.

1.05 SUBMITTALS

A. General:
   1. Submit required submittals as indicated in DIVISION 17 Equipment Specifications and as specified below.
   2. Show dimensions, construction details, wiring diagrams, manufacturers, catalog numbers and all other pertinent details.
   3. Organized and delivered for review by Specification Section.
   4. Submittals that are disorganized, hard to read, incomplete, or otherwise difficult to review will be returned to the CONTRACTOR without review. The CONTRACTOR shall then revise and resubmit the submittal.
   5. Submittal Organization:
      a. Fully Indexed with a tabbed divider for every component:
         1) Provide sequentially numbered pages within the tabbed sections.

2) Submittals that are not fully indexed and tabbed with sequentially numbered pages, will be returned without review.

b. First Page:
   1) Submittal number and description, project name, date, company name.
   2) Specification Section Reference.
   3) Name and telephone number of individual who reviewed submittal before delivery to ENGINEER.
   4) Name and telephone number of individual who was primarily responsible for the preparation of the submittal.

c. Second Page:
   1) List any and all exceptions to the Specifications and provide a statement that all exceptions have been listed.
   2) If a re-submittal, this page shall contain a response to each of the ENGINEER's comments, and/or questions, in the order that the comments and/or questions were presented in the submittal. If ENGINEER'S comments were numbered, include the numbers as references in the response.
   3) Responses shall include the index section and page number on which the comment appeared.

d. Provide Table of Contents.

e. Remaining Pages:
   1) Actual submittal data (cut sheets, Drawings, listing, etc).
   2) Tabbed and labeled dividers.
   3) Pages sequentially numbered.

f. Submittal organization shall be in the same order as the items are referenced, listed, and/or organized in the Specification Section.

6. Exceptions to Specifications:
   a. Include a list of proposed exceptions to the Specifications and Drawings along with a detailed explanation of each. Any exceptions to the Specifications must be noted, and the reason for the exception explained. If there is insufficient explanation for the deviation, the submittal will be returned requiring revision and re-submittal.
   b. Acceptance of any exception is at the sole discretion of the ENGINEER. All items (material, features, functions, performance, etc.) not listed as exceptions shall be furnished strictly in accordance with the Specifications and Drawings.
   c. All items that do not strictly meet the requirements of the Specifications, and were not previously accepted as exceptions, shall be replaced by the CONTRACTOR at no additional cost to the OWNER, even if the submittals contained information indicating the failure to meet the requirements.

7. Responses to ENGINEER's Comments:
   a. Respond to all comments on submittals made by the ENGINEER, either by making the noted correction, and so stating, or stating why it was not revised.
   b. Any re-submittal received by the ENGINEER, which does not contain responses to the ENGINEER's previous comments shall be returned for revision and resubmittal.
   c. No further review by the ENGINEER will be performed until a response for these comments has been received.

8. The ENGINEER has allowed for up to and including two reviews of each submittal. The ENGINEER shall be reimbursed by the OWNER for all reviews after the first two reviews, and the OWNER will deduct the amount of the reimbursement from the CONTRACTOR's contract. The ENGINEER's reimbursement shall be on a time and expense basis and at the current billing rate of the ENGINEER. The ENGINEER shall be the sole authority for determining the suitability of any submittal.

B. Drawings - General:
   1. Coordinate all aspects of the Work so that a complete electrical power, instrumentation, and control system for the facility will be provided and will be supported by accurate Shop and Record Drawings. Every wire, circuit, and terminal provided under this contract must be clearly shown on one or more wiring diagrams submitted.
   2. The wiring and other Shop Drawing submittals shall clearly show all interfaces between any of the following: instruments, vendor control panels, and other equipment related to the instrumentation, control and PCIS system.
   3. Organize the Shop Drawing submittals as indicated below:
      a. Furnish the initial Shop Drawing submittal bound in one or more standard size, 3-ring, D-ring, loose leaf, vinyl plastic, hard cover binders suitable for bookshelf storage.
   4. The Work may include modifications to existing circuits. "Modifications" include changing, modifying, extending, interfacing to, removing or altering an existing circuit. New Drawings must clearly show all modifications to existing circuits. In addition, show all existing unmodified wiring to clearly show the functionality and electrical characteristics of the complete modified circuits.
   5. Field verify existing circuits that will be modified. Any Drawing that shows a modification of an existing circuit must include the name and signature of the individual who performed the field verification work, along with a statement that the individual personally performed the field verification and that the information shown is correct.

C. Instrument Data Sheets and Cut Sheets:
   1. Provide fully completed data sheets for each instrument and component according to ISA S20 Specification Forms for Process Measurement and Control Instruments, Primary Elements and Control Valves. Include the following information on the data sheet, at a minimum:
      a. Component functional description used herein and on the Drawings.
      b. Manufacturers model number or other product designation.
      c. Project tag number used herein and on the Drawings.
      d. Project system or loop of which the component is a part.
      e. Project location or assembly at which the component is to be installed.
      f. Input and output characteristics.
      g. Scale range and units and multiplier.
      h. Requirements for electric supply.
      i. Requirements for air supply.
      j. Materials of construction and of component parts to be in contact with, or otherwise exposed to, process media, and or corrosive ambient air.
      k. Special requirements or features, such as Specifications for ambient operating conditions.
      l. Features and options that are furnished.

2. Provide a technical brochure or bulletin ("cut sheet") for each instrument on the project. Submit with the corresponding data sheets:
   a. Where the same make and model of instrument is used in two or more applications on the project, the process applications are nearly identical, and the materials, features and options are identical one brochure or bulletin may be submitted for the set of identical instruments.
   b. Each brochure or bulletin shall include a list of tag numbers for which it applies.
   c. The technical product brochures shall be complete enough to verify conformance to all Contract Document requirements, and shall be edited to reflect only those features supplied with the device.
   d. Cross out models, features, options, or accessories that are not being provided.
   e. Special options and features, which are furnished, shall be clearly marked and identified.
3. Organization: The data sheets and brochures shall be indexed in the submittal by systems or loops.

D. Shop Drawing Requirements:
   1. Loop Drawings:
      a. Submit Loop Drawings for every analog, discrete, and fieldbus signal and control circuit:
         1) Provide a Loop Drawing submittal that completely defines and documents the contents of each monitoring, alarming, interlock, and control loop on this project. This requirement applies to all signal and control circuits associated with equipment provided under DIVISION 17, DIVISION 16, as well as equipment provided under Sections in other DIVISIONs, including vendor supplied equipment packages and control panels. Include existing and OWNER furnished equipment that is to be incorporated into the PCIS.
      b. Every instrument and I/O point shall be shown on at least one loop diagram.
      c. Provide a complete index in the front of each bound volume.
      d. Tag all loops in a manner consistent with the Contract Documents.
      e. Provide Drawings showing definitive diagrams for every instrumentation loop system:
         1) These diagrams shall show and identify each component of each loop or system using requirements and symbols from ANSI/ISA S5.4 - Instrument Loop Drawings, as defined by the most recent revision in ISA. Include all minimum and optional ISA S5.4 content and information.
         2) Each system or loop diagram shall be drawn on a separate Drawing sheet.
      f. In addition to the ISA S5.4 requirements, the loop diagrams shall also show the following details:
         1) Functional name of each loop.
         2) Reference name, Drawing, and loop diagram numbers for any signal continuing off the loop diagram sheet.
         3) Show all terminal numbers, regardless of the entity providing the equipment.
         4) MCC panel, circuit, and breaker numbers for all power feeds to the loops and instrumentation.

5) Designation of and, if appropriate, terminal assignments associated with, every pullbox, junction box, conduit, and panel through which the loop circuits pass.
6) Show vendor panel, instrument panel, conduit, junction box, equipment and SCADA System terminations, termination identification, wire numbers and colors, power circuits, and ground identifications.
7) P&ID Drawing number.
8) Interconnection Drawing number.
9) Electrical schematic number reference.

2. Instrument Installation Drawings:
   a. Submit, in hard copy format, instrument installation, mounting, and anchoring details for all components and assemblies, including access requirements and conduit connection or entry details.
   b. For each detail, provide, as a minimum, the following contents:
      1) Show all necessary sections and elevation views required to define instrument location.
      2) Ambient temperature and humidity of the environment where the instrument is to be installed.
      3) Corrosive qualities of the environment where the instrument is to be installed.
      4) Process line pipe or tank size, service and material.
      5) Process tap elevation and location.
      6) Upstream and downstream straight pipe lengths between instrument installation and pipe fittings and valves.
      7) Routing of tubing and identification of supports.
      8) Mounting brackets, stands, and anchoring devices.
      9) Conduit entry size, number, location, and delineation between power and signal.
      10) NEMA ratings of enclosures and all components.
      11) Clearances required for instrument servicing.
3. Panel Layout Drawings:
   a. Prepare and submit panel, enclosure, and cabinet layout Drawings for all such items provided or modified as part of this Project.
   b. Include the following information, at a minimum:
      1) Front, side, and plan views to scale.
      2) Dimensions.
      3) Interior and exterior arrangements.
      4) Mounting information, including conduit entrance location.
      5) Tag number and functional name of items mounted in and on panel, console and cabinet.
      6) Nameplate legend that includes text, letter size, and colors to be used.
4. Panel Wiring and Piping Diagrams:
   a. Prepare and submit panel wiring and piping diagrams for every panel modified as part of this Project.
   b. Include the following information:
      1) Name of panel.
      2) Wiring and piping sizes and types.
      3) Terminal strip numbers. Wire tags and labels.
      4) Functional name and manufacturer's designation for items to which wiring and piping are connected.

5) Electrical control schematics in accordance with ANSI standards.

5. Electrical Control Schematics:
   a. Show discrete control circuits in a "ladder diagram" format.
   b. Document all electrical equipment control circuits provided or modified under this Contract with an Electrical Control Schematic:
      1) Where a required Electrical Control Schematic is provided in the Contract Documents, update it with additional information including, but not limited to, terminal and wire numbers.
      2) Update all electrical control schematics to reflect as-built conditions and submit for review.

E. Testing, Calibration, and Start-Up Submittal:
   1. General testing submittal requirements are specified in this Section.
   2. Provide certified and witnessed test and calibration checklists for each of the following tests:
      a. Calibration, adjustment and test details for all components and systems.
      b. Loop Validation Tests.

F. Technical (Operations and Maintenance) Manuals:
   1. Each set shall consist of 1 or more volumes, bound in standard size, 3-ring, D-ring, loose-leaf, vinyl plastic, hard cover binder suitable for bookshelf storage.
   2. Organize the Technical Manuals for each process in the following manner:
      a. Section A - Process and Instrumentation Diagrams.
      b. Section B - Loop Drawings.
      c. Section C - Instrument Data Sheets and Brochures.
      d. Section D - Instrumentation Installation Details.
      e. Section E - Test Results.
      f. Section F - Operational Manual.
      g. Section G - Spare Parts List.
   3. Provide signed results from Calibration, Loop Testing, Pre-commissioning, and Performance Testing and include them in Section E - Test Results.
   4. Provide installation, connection, operating, calibration, setpoints (e.g., pressure, pump control, time delays, etc.), adjustment, test, troubleshooting, maintenance, and overhaul instructions in complete detail.
   5. Spare Parts List:
      a. Include a list of recommended spare parts for all the equipment furnished under this Section:
         1) Include recommended quantities sufficient to maintain the furnished system for a period of 5 years.
         2) After final system acceptance, annotated the list to indicate which items, if any, and quantity are furnished as part of this Contract.

1.06 DELIVERY, STORAGE, AND PROTECTION

A. Store all equipment and materials delivered to the job site in a location that will not interfere with the operations of the CONTRACTOR, other contractors on the site, or the OWNER.

B. Tagging:
   1. Each component and/or instrument shall be tagged to identify its location, instrument tag number, and function in the system.

2. A permanent stainless steel or other non-corrosive material tag firmly attached and permanently and indelibly machine marked with the instrument tag number, as given in the tabulation, shall be provided on each piece of equipment.
3. Instruments shall be tagged immediately upon receipt in the field.
4. Tags shall utilize the Tag and Loop Number identifications shown of the P&IDs.

C. Storage:
1. Storage and handling shall provide maximum protection to the equipment and materials.
2. Store instruments in complete conformance with the manufacturer's recommendations.
3. Equipment shall not be stored outdoors.
4. Replace or repair any apparatus that has been damaged.

1.07 PROJECT OR SITE CONDITIONS

A. As specified within Sections 01612, 01614, and 16050.

B. Instrumentation and controls shall be designed and constructed for satisfactory operation and long, low maintenance service under the following environmental conditions:
1. Instruments and All Outdoor Equipment:
a. Ambient Temperature Range: -7 degrees Celsius through 55 degrees Celsius (20 degrees Fahrenheit through 131 degrees Fahrenheit).
b. Thermal Shock: 1.0 degrees Celsius (1.8 degrees Fahrenheit) per minute maximum.
c. Relative Humidity: 0 to 100 percent maximum.

1.08 SEQUENCING

A. Loop Validation Test:
1. Testing shall be completed and demonstrated to the OWNER.

B. All special tools and spare parts, refer to paragraph 1.10 of this Section, shall be submitted suitably wrapped and identified.

C. Acceptance: For the purpose of this project, the following conditions shall be fulfilled before the WORK is considered complete:
1. All submittals have been completed and approved.
2. Modifications and additions to the PCIS have been calibrated and loop tested.
3. All required spare parts and expendable supplies and test equipment have been delivered to the OWNER.
4. The performance test has been successfully completed.
5. All debris associated with installation of instrumentation has been removed.
6. All probes, elements, transmitters, tubing, and enclosures have been cleaned and are in like-new condition.

1.09 WARRANTY

A. The CONTRACTOR shall warrant the performance and the hardware of all instrumentation and control equipment and installation, as specified herein, for a period of one (1) year following the date of Final Acceptance of the WORK:
   1. Services to correct any defect shall be performed within 3 calendar days after notification by the OWNER of a defect.

B. Equipment and materials that do not achieve design requirements after installation shall be replaced or modified to attain compliance. Following replacement or modification, retest the system and perform additional testing to place the complete system in satisfactory operation and attain compliance approval from the ENGINEER.

C. The cost of all parts, material, labor, travel, subsistence, or other expenses incurred in providing services and service visits during the warranty period shall provided at no additional cost to the OWNER.

D. The CONTRACTOR shall be responsible for furnishing the spare parts and tools on site at inventory levels sufficient to meet the response and repair times specified. All spare parts stored on-site shall become the property of the OWNER upon completion of the warranty period.

1.10 MAINTENANCE

A. Furnish the following:
   1. A fuse for fuse replacement for every fuse used in the system.

B. Provide additional spare parts specified in other Sections of this DIVISION.

C. Submit all special tools and spare parts, suitably wrapped and identified, before performance testing commences.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Allowable manufacturers are specified in individual instrument and equipment Specifications in other Sections of DIVISION 17.

2.02 MATERIALS

A. All materials furnished under this contract shall be new, free from defects, and shall be standard products produced by manufacturers regularly engaged in the production of these products.

2.03 EQUIPMENT

A. All equipment furnished under this contract shall be new, free from defects, and shall be standard products produced by manufacturers regularly engaged in the production of these products.

B. All instrumentation shall be suitable for operation in the ambient conditions at the equipment installation locations:
   1. All enclosures shall match the area classifications as detailed in Section 16050 or as indicated on the Drawings.
   2. Field instrument enclosures shall be NEMA 4 minimum. For corrosive environments, or where otherwise specified, enclosures shall be NEMA 4X.

2.04 COMPONENTS

A. All meters, instruments, and other components shall be the most recent field proven models marketed by their manufacturers at the time of submittal of the Shop Drawings unless otherwise specified to match existing equipment.

B. Unless otherwise specified, each individual instrument shall have a minimum accuracy of ±0.5 percent of full scale and a minimum repeatability of ±0.25 percent of full scale.

C. Signal Transmission:
   1. Analog measurements and control signals shall be as indicated herein, and unless otherwise indicated, shall vary in direct linear proportion to the measured variable.
   2. Electrical analog signals outside control panels shall be 4 to 20 milliamperes DC except as indicated.
   3. Analog signals within enclosures may be 1 to 5 volts DC.
   4. All electric signals shall be electrically or optically isolated from other signals.
   5. Discrete input signal shall be as shown on the Drawings, unless otherwise noted.
   6. Discrete output signals shall be:
      a. 120 VAC dry contact or TRIAC output as needed to coordinate with the field device, unless otherwise noted.
      b. All discrete outputs without exception shall be routed through an external terminal block mounted fuse with blown fuse indication.
      c. Discrete outputs from PLCs where the current exceeds 1 amp shall utilize interposing relays to completely isolate the PLC discrete output from the field circuit.
   7. Unless otherwise specified, analog signal transmission between instruments not located within a common panel shall be 4 to 20 milliamperes and operate at 24 volt DC.
   8. Milliamperes signals shall be current regulated and not affected by changes in supply voltage and load resistance within the unit's rating.
   9. Total loop impedance for 4 to 20 milliamperes signals shall not exceed the rated value for the regulating device at the loop operating voltage.
   10. Where necessary, loop impedance shall be reduced by providing current-to-current (I/I) isolation amplifiers for signal re-transmission.

D. Grounding:
   1. Shields and measurement loops shall be single point grounded at the source panel external terminals by bonding to the instrument panel signal ground bus.
   2. Isolating amplifiers shall be provided within the panel for field equipment possessing a grounded input or output, except when the panel circuit is galvanically isolated.

E. Control Circuit Breakers:
   1. DIN rail mounting on 35mm rail.
   2. Manual OPEN-CLOSE Switch.
   3. Rated 250 VAC.
   4. Interrupt Rating: 10 KAIC.
   5. Current Ratings: As indicated on the Drawings.
   6. Provide nameplate identifying each circuit breaker, refer:
      a. In accordance with Section 16075.
   7. Manufacturer: One of the following:
      a. Phoenix Contact.
      b. ABB.
      c. Allen Bradley Series.
      d. Square D.
      e. Entrelec.

F. Panel Meters:
   1. Digital:
      a. Self-contained instruments that display process signals directly in engineering units.
      b. Suitable for panel mounting.
      c. LED display:
         1) 0.6-inch height (minimum).
   2. Multi-Range Capabilities:
      a. General:
         1) Integral provisions for scaling.
         2) Switch programmable decimal points.
         3) NEMA 4/IP65 sealed front bezel.
      b. Current and Voltage indicators:
         1) 3 1/2 - digit.
         2) Accuracy:
            a) AC/DC volts: ± (0.1 percent of reading + 1 digit).
            b) 0 - 10V: ± (0.1 percent of reading + 1 digit).
         3) Ratings, protection, and indication:
            a) Maximum applied voltage: 300 VAC/VDC.
      c. Operating voltage: 120 VAC.
      d. Operating temperature: 0 degrees Celsius to 60 degrees Celsius.
         1) Manufacturer, one of the following:
            a) Red Lion.

2.05 ACCESSORIES

A. Flow conditioning devices or other required accessories shall be furnished and installed if necessary to meet the accuracy requirements in the Contract Documents.

B. Shade canopies shall be fabricated for all instrumentation or equipment mounted outdoors having contact with direct sunlight. The canopies shall afford protection for the equipment which shall be mounted facing north (operator faces south).

PART 3 EXECUTION

3.01 EXAMINATION

A. Review the existing site conditions and examine all Shop Drawings for the various items of equipment in order to determine exact routing and final terminations for all wiring and cables.

B. The CONTRACTOR is responsible for the complete electrical and instrumentation work.
   1. Install all extra conduits, cables, and interfaces as may be necessary to provide a complete and operating electrical and PCIS system, at no additional cost to the OWNER.

3.02 INSTALLATION

A. Installation work shall be performed by individuals who are skilled and experienced in the installation and connection of all elements, instruments, accessories, and assemblies.

B. Perform all related electrical work in accordance with the applicable Sections of DIVISION 16.

C. The monitoring and control system configurations are diagrammatic:
   1. The locations of equipment are approximate unless dimensioned.
   2. Where job conditions require reasonable changes in approximated locations and arrangements, make such changes without extra cost to the OWNER.

D. Field Instruments Installation:
   1. Install field instruments in accordance with the Contract Documents, ANSI/API 550 and 551, and the manufacturer's instructions.
   2. Mount field instruments so that they can be easily read, can be readily approached and easily serviced, and so they do not restrict access to mechanical equipment:
      a. Mount field instruments on a pipe stand or local panel, if they are not directly mounted, unless otherwise indicated on the Drawings.
   3. Provide sun shields for field electronic instruments exposed to direct sunlight:
      a. Orient and shield LED, LCD, or other digital readouts to eliminate exposure to direct sunlight.
   4. Connections from rigid conduit systems to field instruments shall be made with jacketed flexible conduit (using the type of flexible conduit required for the area classification) with a maximum length of 18 inches.
   5. Field instruments shall be connected with cable as specified in DIVISION 16, except when the manufacturer requires the use of special cable, or otherwise specified herein. Special cable applications shall be in accordance with the NEC.
   6. Verify the correctness of each installation, including polarity of electric power and signal connections, and making sure all process connections are free of leaks.
   7. Provide a power disconnect switch (NEMA 4X, or explosion-proof if required by area classification) for 120 VAC powered instrument which does not have a built-in power disconnect.

E. The OWNER reserves the right to require minor changes in location of equipment before rough in.

F. Conduit, Cables, and Field Wiring:
   1. Conduit is specified in DIVISION 16.
   2. Signal circuits, control wiring, signal wiring to field instruments, and other field wiring and cables are specified in DIVISION 16.
   3. Provide terminations and wire identification as specified in DIVISION 16.
   4. Arrange all wire and cable in a neat manner and securely supported in cable groups and connected from terminal to terminal without splices unless specifically approved by the ENGINEER. Protect all wiring from sharp edges and corners.

G. Equipment Tie-Downs:
   1. Anchor all instruments, control panels, and equipment by methods that comply with seismic and wind bracing requirements, which apply to the site.
   2. All control panels, VCPs, LCPs, etc., must be permanently mounted and tied down to structures.

H. Instrument Tagging:
   1. All field-mounted instruments shall be provided with stainless steel tags stamped or engraved with the instrument's full tag number. Affix tags with stainless steel wire fasteners.
   2. Provide all back of panel instruments with black-white-black plastic laminate nameplates engraved with the instrument's full tag number. Secure nameplates to the panel with stainless steel screws.
   3. All front of panel instruments shall include the instrument's full tag number and service description in the nameplate legend. Unless it is part of the instrument, the nameplate shall be engraved black-white-black plastic laminate, secured with stainless steel screws. Use an approved adhesive if screws would violate the NEMA or other rating on the enclosure.

I. Electrical Marking:
   1. All electrical devices, terminal blocks, terminals, cables, and conductors shall be machine printed and clearly labeled.
   2. Fit all cables and conductors with a heat shrink identification sleeve.
      a. Adhesive tape identification markers shall not be used.
      b. Provide a unique numbering system that conforms to requirements specified in DIVISION 16.
   3. Tag cables at both ends and at any intermediate pull box or manhole through which the cables are routed:
      a. Identify all cables on the CONTRACTOR's cable schedule.

J. Cable and Conductor Termination:
   1. Terminate all cables and conductors on terminal blocks with full identification.
   2. Terminal Block Enclosures:
      a. Field mounted terminal blocks shall have NEMA 4 enclosures or NEMA 4X enclosures in wet or corrosive areas unless otherwise specified.

K. Surge Protection:
   1. Provide outdoor field instrument loops with voltage surge protection units at instruments, capable of limiting voltage to 30 volt DC peak with a response

time of 5 nano-seconds, and dissipating a 15,000 watt, 1 millisecond surge. Provide 24 VDC line to line, and line to ground protection.

2. Individually fuse each 4-20 mA DC loop with a 1/16 ampere [slow blow] fuse between power supplies and receiver surge protectors.
3. Provide voltage surge protection for 4 wire transmitters and analyzers with 120 VAC power sources. Protect both 120 VAC power source and 24 VDC signal loop.

3.03 FIELD QUALITY CONTROL

A. Installation Supervision: The CONTRACTOR shall verify that all PCIS instruments and equipment are installed in a proper and satisfactory manner.

3.04 CLEANING

A. All control panels and enclosures installed or modified as part of this Project shall be vacuumed clean before start-up and again after final completion of the project.

B. Clean all panel surfaces; return to new condition any scratches and/or defects. If in the ENGINEER's opinion the panel repairs do not constitute new condition, they shall be replaced with new panels.

C. All instrument faces and enclosures shall be wiped and/or vacuumed clean.

D. Wiring in panels, boxes, and other locations shall be left neat, clean, and organized. Spare wiring lengths shall be neatly coiled and labeled. Excessive spare wire and cable lengths, as determined by the ENGINEER, shall be shortened, re-terminated, and re-labeled.

END OF SECTION

SECTION 17101

CONTROL STRATEGY
SODIUM HYPOCHLORITE SYSTEM

PART 1 GENERAL

1.01 SUMMARY

A. A 12.5 percent solution of sodium hypochlorite is used for supplemental disinfection downstream of the primary UV disinfection system, filter influent or effluent.

1.02 REFERENCES

A. P&IDS:
   1. N-02.

B. Instrument Index and PLC I/O List:
   1. 17901 Schedules-Field Instruments.
   2. 17903 I/O List.

1.03 SYSTEM DESCRIPTION

A. The diaphragm chemical metering pumps are controlled by Local Control Panel and PLC control system.

B. The sodium hypochlorite system consists of an existing 4,000-gallon storage tank, existing chemical metering pump, two new diaphragm chemical metering pumps, two new high pressure switches, and new associated valves and piping.

1.04 EQUIPMENT

Equipment No.	Equipment Name/Description
65-CHLO-TNK-101	Sodium Hypochlorite Storage Tank (Existing)
65-CHLO-LE-101	Storage Tank Level (Existing)
65-CHLO-PMP-102	Sodium Hypochlorite Metering Pump No. 2
65-CHLO -PMP- 103	Sodium Hypochlorite Metering Pump No. 3
65-CHLO-PSH-102	High Discharge Pressure Switch
65-CHLO-PSH-103	High Discharge Pressure Switch

1.05 ALARMS

A. Alarms annunciated on the PLC control system are the following:

Alarm No.	Alarm Description
LAH-101	Sodium Hypochlorite Storage Tank High Level Alarm
LAL-101	Sodium Hypochlorite Storage Tank Low Level Alarm
YA-102A,103A	Sodium Hypochlorite Metering Pump Failure Alarm
YA-102B,103B	Sodium Hypochlorite Metering Pump Discharge High Pressure Alarm

1.06 OPERATION

A. Local Control:
   1. Each pump is furnished with a local control panel. The local control panel has a HAND/OFF/AUTO selector switch.
   2. In the HAND mode, the operator can Start and Stop the pump.
   3. The operator can manually adjust the pump stroke length at the pump.

B. Automatic Control:
   1. In the AUTO mode, pumps 65-CHLO-PMP-102, 103 are controlled by the PLC control system in either a Manual or Automatic mode.
   2. In the Manual mode, the operator can start and stop the pump and adjust the pump speed at the PLC control System Operator Interface Station.
   3. In the AUTO mode, the PLC control system will control the pump based on the time averaged plant effluent flow and trim based on residual.
   4. The PLC control system will start and stop the pump and adjust the pump speed based on the sodium hypochlorite concentration (operator entered), time averaged filter effluent flow rate and an operator entered dosage.

C. Control Function in the PLC:
   1. The following set points shall be entered at the PLC graphic screen.
      a. C: Chemical Concentration (%). Initial Value = 12.5%. This set point is the concentration of the sodium hypochlorite solution as delivered.
      b. R: Chlorine Residual (ppm). Initial Value = 2 ppm. This set point is desired chlorine residual.
   2. The PLC shall continually monitor the following for use in sodium hypochlorite metering calculation.
      a. UV System effluent chlorine residual as measured by the chlorine residual indicating analyzer.
   3. The operator may verify the PLC controlled feed rate by using the following calculation for the sodium hypochlorite feed rate as follows:

$$Feed\ Rate\ (gph) = \frac{4.17 \times Q \times DR}{C}$$

      a. Where "DR" is the desired outlet chlorine residual as measured by the UV system effluent chlorine residual indicating analyzer and "Q" is the filter effluent flow rate (mgd) as measured by the filter effluent flow meter transmitter.
   4. The pump speed output from the PLC shall be controlled by a proportional-integral-derivative (PID) flow algorithm as follows:
      a. The PID set point shall be the desired discharge chlorine residual.
      b. The PID process variable shall be the discharge chlorine residual as measured by the UV system effluent chlorine residual indicating analyzer.
      c. The PID output shall be the pump speed output from the PLC to the sodium hypochlorite metering pump. The pump speed output shall be scaled 0 - 100% equal to a 4-20 mA signal.
      d. The PID algorithm shall modulate the pump speed as necessary to maintain the desired chlorine residual set point.

D. Interlocks:
   1. At a low level setpoint (LAL-101) in the sodium hypochlorite storage tank (65-CHLO-TNK-101), the PLC control system will stop the metering pumps, 65-CHLO-PMP-102, 103. Coordinate with the Sodium Bisulfite PLC control system so that the sodium hypochlorite storage tank level is available for interlocking of pumps 65-DCLO-PMP-101 and 102.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

Not Used.

END OF SECTION

SECTION 17102

CONTROL STRATEGY
SODIUM BISULFITE SYSTEM

PART 1 GENERAL

1.01 SUMMARY

A. A 38 percent solution of sodium bisulfite is used for dechlorination at the UV disinfection system effluent.

1.02 REFERENCES

A. P&IDS:
   1. N-03.

B. Instrument Index and PLC I/O List:
   1. 17901 Schedules-Field Instruments.
   2. 17903 I/O List.

1.03 SYSTEM DESCRIPTION

A. The diaphragm chemical metering pumps are controlled by Local Control Panel and PLC control system.

B. The new sodium bisulfite system consists of a 1,500-gallon storage tank, two diaphragm chemical metering pumps, high pressure switches, and associated valves and piping.

1.04 EQUIPMENT

Equipment No.	Equipment Name/Description
65-DCLO-TNK-101	Sodium Bisulfite Storage Tank
65-DCLO-LE-101	Storage Tank Level
65-DCLO-PMP-101	Sodium Bisulfite Metering Pump No. 1
65-DCLO -PMP- 102	Sodium Bisulfite Metering Pump No. 2
65-DCLO-PSH-101	High Discharge Pressure Switch
65-DCLO-PSH-102	High Discharge Pressure Switch

1.05 ALARMS

A. Alarms annunciated on the PLC control system are the following:

Alarm No.	Alarm Description
LAH-101	Sodium Bisulfite Storage Tank High Level Alarm
LAL-101	Sodium Bisulfite Storage Tank Low Level Alarm
YA-101A,102A	Sodium Bisulfite Metering Pump Failure Alarm
YA-101B,102B	Sodium Bisulfite Metering Pump Discharge High Pressure Alarm

1.06 OPERATION

A. Local Control:
   1. Each pump is furnished with a local control panel. The local control panel has a HAND/OFF/AUTO selector switch.
   2. In the HAND mode, the operator can Start and Stop the pump.
   3. The operator can manually adjust the pump stroke length at the pump.

B. Automatic Control:
   1. In the AUTO mode, pumps 65-DCLO-PMP-101, 102 are controlled by the PLC control system in either a Manual or Automatic mode.
   2. In the Manual mode, the operator can start and stop the pump and adjust the pump speed at the PLC control System Operator Interface Station.
   3. In the AUTO mode, the PLC control system will control the pump based on the time averaged plant effluent flow and trim based on residual.
   4. The PLC control system will start and stop the pump and adjust the pump speed based on the sodium bisulfite concentration (operator entered), time averaged filter effluent flow rate and an operator entered dosage.

C. Control Function in the PLC:
   1. The following set points shall be entered at the PLC graphic screen.
      a. C: Chemical Concentration (%). Initial Value = 38%. This set point is the concentration of the sodium bisulfite solution as delivered.
      b. R: Chlorine Residual (ppm). Initial Value = 0.04 ppm. This set point is desired chlorine residual.
   2. The PLC shall continually monitor the following for use in sodium bisulfite metering calculation.
      a. Effluent pump station chlorine residual as measured by the new chlorine residual indicating analyzer.
   3. The operator may verify the PLC controlled feed rate by using the following calculation for the sodium bisulfite feed rate as follows:

$$Feed\ Rate\ (gph) = \frac{0.365 \times Q \times DR}{C}$$

      a. Where "DR" is the desired outlet chlorine residual as measured by the Effluent pump station chlorine residual indicating analyzer and "Q" is the filter effluent flow rate (mgd) as measured by the filter effluent flow meter transmitter.
   4. The pump speed output from the PLC shall be controlled by a proportional-integral-derivative (PID) flow algorithm as follows:
      a. The PID set point shall be the desired discharge chlorine residual.
      b. The PID process variable shall be the chlorine residual as measured by the Effluent pump station chlorine residual indicating analyzer.
      c. The PID output shall be the pump speed output from the PLC to the sodium bisulfite metering pump. The pump speed output shall be scaled 0 - 100% equal to a 4-20 mA signal.
      d. The PID algorithm shall modulate the pump speed as necessary to maintain the desired chlorine residual set point.

D. Interlocks:
   1. At a low level setpoint (LAL-101) in the sodium bisulfite storage tank (65-DCLO-TNK-101), the PLC control system will stop the metering pumps, 65-DCLO-PMP-101, 102.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

Not Used.

END OF SECTION

SECTION 17206

LEVEL MEASUREMENT – ULTRASONIC

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Requirements for ultrasonic level transmitters for permanent installations.
   2. Related Sections:
      a. The Contract Documents are a single integrated document, and as such all DIVISIONs and Sections apply. It is the responsibility of the CONTRACTOR and its Subcontractors to review all Sections to provide a complete and coordinated project.

B. Provide all instruments identified on the P&IDs, instrument lists, and instrument data sheets.

1.02 REFERENCES

A. See Section 17050 for a list of references.

1.03 DEFINITIONS

A. Definitions of terms are specified in Section 17050.

1.04 SUBMITTALS

A. Furnish submittals in accordance with Section 17050.

B. Furnish complete Product Data, Shop Drawings, Test Reports, Operating Manuals, Record Drawings, Manufacturer's certifications, Manufacturer's Field Reports, and other submittals as specified in Section 17050, and below.

C. Product Data:
   1. Dimensional Drawings.
   2. Measurement accuracy.
   3. Range and rangeability.
   4. Response time.
   5. Enclosure rating.
   6. Classification rating.
   7. Manufacturers certification for installation conditions of the Instrument.
   8. Power:
      a. Voltage.
      b. Wattage.
   9. Output options.

D. Shop Drawings:
   1. Connection diagram.
   2. Loop diagram.

3. Mounting drawings.

1.05 QUALITY ASSURANCE

A. Instruments shall be manufactured at facilities certified to the quality standards of ISO Standard 9001 - Quality Systems - Model for Quality Assurance in Design/Development, Production, Installation, and Servicing.

B. Ultrasonic transmitters shall be factory calibrated on an approved test stand with certified accuracy traceable to NIST.

1.06 DELIVERY, STORAGE, AND HANDLING

A. As specified in Section 17050.

B. Store all instruments in a dedicated structure with space conditioning to meet the recommended storage requirements provided by the manufacturer:
   1. Replace any instruments that are not stored in strict conformance with the manufacturer's recommendation.

1.07 PROJECT CONDITIONS

A. Provide manufacturer's certification that the instruments are suitable for the installed site conditions including, but not limited to, material compatibility, site altitude, site seismic conditions, process and ambient temperature, and humidity conditions.

B. Refer to Section 17050 for project environmental conditions.

1.08 WARRANTY

A. Refer to Section 17050.

1.09 MAINTENANCE

A. Provide all parts, materials, fluids, etc. necessary for maintenance and calibration purposes throughout the warranty period. Deliver all of these supplies prior to project substantial completion.

B. Provide additional spare parts and spare instruments as specified in Section 17050.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Acceptable Ultrasonic Level Instruments shall be as listed below.

2.02 MANUFACTURED UNITS

A. Continuous non-contact level measurement device with remote transmitter:
   1. General: Continuous non-contact level measurement device with remote transmitter using ultrasonic echo sensing. The transducer generates an ultrasonic pulse in the range of 12 to 45 kHz and measures the time required

for the pulse to travel to the process surface and return. The level is measured based on constant velocity of sound in air with temperature compensation to adjust for velocity changes relative to temperature:

a. Each level transmitter system includes but not limited to:
    1) Ultrasonic transducer.
    2) Signal cable.
    3) Transmitter.

2. Ultrasonic Level measurement with 4 wire remote transmitter shall be one of the following - no equal:
    a. Manufacturers:
        1) Siemens: HydroRanger 200.
3. Performance Requirements:
        1) Accuracy:
            a) 0.25 percent of range.
        2) Repeatability:
            a) 0.1 percent of range.
        3) Range:
            a) As indicated in the Drawings.
4. Ultrasonic Transducer:
    a. Encapsulated in chemical and corrosion-resistant material:
        1) Kynar.
        2) The transducer material specified represents the manufacturer's standard product. Ensure that the transducer is compatible with each of the unique chemicals required for the project.
    b. Operating Temperature Range: -5 degrees Fahrenheit to 131 degrees Fahrenheit (-20 degrees Celsius to 55 degrees Celsius).
    c. Class 1, Division 1.
    d. Operating Relative Humidity Range: 5 to 95 percent.
    e. Range and Sensor Sensitivity: 1 to 50 feet.
    f. Functions:
        1) Single Level measurement.
        2) Programmable for:
            a) Tank volume.
            b) Open channel flow calculations.
5. Transmitter:
    a. Level Indicating Transmitter:
        1) Indicator: Liquid Crystal Diode indicator with approximately 0.50-inch display scaled to read in engineering units.
        2) Sensitivity: Able to ignore momentary level spikes or momentary loss of echo and indicate loss of echo condition on indicating transmitter unit.
        3) Connection to a PC computer to allow for signal profiles and echo mapping:
            a) Provide manufacturers software for re-mapping the signal.
        4) Transmitter Signal Output:
            a) Analog Output 4-20 mA DC, with HART Communication Protocol into 500 ohm load at 24 VDC, linearly proportional to measured level range.
        5) Enclosure: NEMA 4X, suitable for wall or pipe stand mounting.
        6) Operating temperature range from -5 degrees Fahrenheit to 131 degrees Fahrenheit (-20 degrees Celsius to 55 degrees Celsius), relative humidity of 10 to 100 percent.

7) Power Supply:
   a) 120 VAC ± 10 percent.
   b) 60 Hz.
   c) 60 VA.

6. Process Connection:
   a. 3-inch flange.

2.03 ACCESSORIES

A. Mounting Brackets: As indicated in the Drawings.

B. Solar Protection: Provide sunshades for all outdoor units.

2.04 SOURCE QUALITY CONTROL

A. Each transmitter shall be calibrated at a facility that is traceable to the National Institute of Standards and Technology (NIST).

B. A real-time computer generated printout of the actual calibration data indicating apparent and actual levels at 20 percent, 40 percent, 60 percent, 80 percent and 100 percent of the calibrated range shall be submitted to the ENGINEER and included in the O&M.

C. Provide complete documentation covering the traceability of all calibration instruments.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine the complete set of plans, the process fluids, pressures, and temperatures and furnish instruments that are compatible with installed process condition.

B. Examine the installation location for the instrument and verify that the instrument will work properly when installed.

C. Notify the ENGINEER promptly if any installation condition does not meet the instrument manufacturer's recommendations or Specifications.

3.02 PREPARATION

A. As specified in Section 17050.

3.03 INSTALLATION

A. As specified in Section 17050.

3.04 FIELD QUALITY CONTROL

A. Site Test and Inspection:
   1. Perform installed tests in accordance with Section 17050.

3.05 ADJUSTING

A. Calibrate all instruments in accordance with the manufacturer's instructions.

B. Perform any supplemental calibration specified in Section 17050.

3.06 CLEANING

A. Vacuum all instrument enclosures clean after calibration and before commissioning. See Section 17050 for additional requirements.

3.07 TRAINING

A. As specified in Section 17050.

3.08 PROTECTION

A. Protect all instruments after installation and before commissioning. The CONTRACTOR shall replace any instruments damaged prior to commissioning:
   1. The ENGINEER shall be the sole party responsible for determining the corrective measures.

3.09 SCHEDULES

A. The following instrument list for 4 wire devices is included as a guideline for the supply of instruments. This list is not complete. Some information needed to order and specify the required instruments is not included:
   1. The instrument list does not necessarily include all required instruments. Furnish all instruments identified on the P&IDs, Contract drawings, instrument lists, and in the Specifications. If an instrument is shown on one of these documents, it shall be considered to be shown on all:
      a. XXX-LEU-XXX/XXX-LIT-XXXX.

B. Produce completed Instrument Data Sheets for each and every instrument required in DIVISION 17 and for each and every instrument shown on the P&IDs. See Section 17050 for additional requirements. Submit all Instrument Data Sheets for review. Instrument Data Sheets shall be furnished in both hard copy and electronic format.

END OF SECTION

SECTION 17401

PRESSURE/VACUUM MEASUREMENT - DIAPHRAGM AND ANNULAR SEALS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes requirements for:
   1. Diaphragm seals for permanent installations.
   2. Annular seals for permanent installations.

B. Related Sections:
   1. The Contract Documents are a single integrated document, and as such all DIVISIONS and Sections apply. It is the responsibility of the CONTRACTOR and its subcontractors to review all Sections to ensure a complete and coordinated project.

C. Provide all seals identified on the Drawings and Instrument Index

1.02 REFERENCES

A. Refer to Section 17050.

1.03 DEFINITIONS

A. Refer to Section 17050.

1.04 SUBMITTALS

A. Furnish submittals in accordance with Sections 01330 and 17050.

B. Furnish complete Product Data, Shop Drawings, Test Reports, Operating Manuals, Record Drawings, Manufacturer's Certifications, Manufacturer's Field Reports, and other submittals as specified in Section 17050, and below.

C. Additional Requirements:
   1. Product Data:
      a. Manufacturer's installation instructions.
      b. Seal type.
      c. Body materials.
      d. Diaphragm material.
      e. Fill fluid type.
      f. Seal size.
      g. Options.
      h. Process connection.

1.05 QUALITY ASSURANCE

A. Seals shall be manufactured at facilities certified to the quality standards of ISO Standard 9001 - Quality Systems - Model for Quality Assurance in Design/Development, Production, Installation, and Servicing.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Refer to Section 17050.

B. Store all instruments in a dedicated structure with space conditioning to meet the recommended storage requirements provided by the manufacturer:
   1. Replace any instruments that are not stored in strict conformance with the manufacturer's recommendation.

1.07 PROJECT OR SITE CONDITIONS

A. Refer to Section 17050 for project environmental conditions.

1.08 WARRANTY

A. Refer to Section 17050.

B. In addition to the requirements of Section 17050, provide extended manufacturer's warranty for each instrument for a period of 2 years after project substantial completion.

1.09 MAINTENANCE

A. Provide all parts, materials, fluids, etc., necessary for maintenance and calibration purposes throughout the warranty period. Deliver all of these supplies before project substantial completion.

B. Provide additional spare parts and spare instruments as specified in Section 17050.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Diaphragm Seals:
   1. For liquids with pulsating flow having pressures less than or equal to 15 psi: One of the following or equal:
      a. Ashcroft, Type 301.
      b. Mansfield and Green, Type LG.
      c. Wika.
      d. Noshok.
      e. Rosemount.
   2. For liquids with pulsating flow having pressures greater than or equal to 15 psi: One of the following or equal:
      a. Ashcroft, Type 101.
      b. Mansfield and Green, Type RG.
      c. Wika.
      d. Noshok.
      e. Rosemount.
   3. For chlorine under pressure: One of the following or equal:
      a. Ashcroft, Type 101.
      b. Mansfield and Green, Type RG.
      c. Wika.

d. Noshok.
e. Rosemount.

B. Annular Seals:
1. One of the following:
a. Onyx Valve.
1) No equal.

2.02 MANUFACTURED UNITS

A. Diaphragm Seals:
1. General:
a. Diaphragm seal and pressure instrument shall be assembled by pressure instrument manufacturer and shipped as an assembly.
2. Technical Requirements:
a. Seal Type: Welded.
b. Process Connection: 1/2 inch NPT.
c. Instrument Connection: 1/2 inch NPT.
d. Provide fill/bleed connection.
e. Provide flushing connection.
f. Mounting: Direct mount to pressure instrument.
g. Nuts and Bolts: 316 stainless steel.
1) Except for Sodium Hypochlorite applications.
h. Materials of Construction:
1) Sewage, sludge, liquids containing solids, and liquids with pulsating flow having pressures less than or equal to 15 psi:
a) Diaphragm: Viton.
b) Lower Housing: 316 stainless steel.
c) Upper Housing: Manufacturer's standard.
d) Fill Fluid: Silicon oil.
2) Sewage, sludge, liquids containing solids, and liquids with pulsating flow having pressures greater than 15 psi:
a) Diaphragm: 316 stainless steel.
b) Lower Housing: 316 stainless steel.
c) Upper Housing: Manufacturer's standard.
d) Fill Fluid: Silicon oil.
3) Chlorine:
a) Diaphragm: Tantalum.
b) Lower Housing: Hastelloy C.
c) Upper Housing: Manufacturer's standard.
d) Fill Fluid: Halocarbon.
4) Other Process Fluids: As recommended by manufacturer and with ENGINEER's approval.

B. Annular Seals:
1. General:
a. Inside diameter of annular seal shall provide uninterrupted flow:
1) There shall be no dead ends or crevices.
2) Process flow shall be sufficient to make the annular seal self-cleaning.
b. The pressure sensing flexible cylinder shall measure pressure around the full inside circumference of the pipeline.

2. Technical Requirements:
   a. Pressure Rating: Equivalent to the ANSI flanges.
   b. Materials of Construction:
      1) Inner Flexible Cylinder: Manufacturer's standard.
         a) Provide suitable, ENGINEER approved substitute should Buna N be incompatible with the specific process fluid.
      2) Body: Carbon steel.
      3) Assembly Flanges: 316 stainless steel
      4) Fill Fluid:
         a) Silicon oil for non Chlorine based processes
         b) Halocarbon. For Chlorine based processes.
   c. Nominal Pipe Size: As indicated on the Drawings.
   d. Process Connection:
      1) Wafer for Annular Seals.
      2) Class 150 Raised Face Flange or Class 300 Raised Face Flange (depending upon process requirements) for diaphragm seals.
   e. Instrument Connection: 1/2 inch NPT.

2.03 ACCESSORIES

A. Sodium hypochlorite and ferric chloride service: Provide PVC shutoff cock.

B. Provide common Calibration Unit for Annular Seals:
   1. Onyx Valve Calibrating Machine.
   2. Onyx Isolator Ring Syringe Tool.

2.04 SOURCE QUALITY CONTROL

A. Refer to Section 17050 and noted herein.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine the complete set of Drawings for process fluids, pressures, and temperatures. Provide instruments that are compatible with installed process condition.

B. Examine the installation location for the instrument and verify that the instrument will work properly when installed.

C. Notify the ENGINEER promptly if any installation condition does not meet the instrument manufacturer's recommendations or Specifications.

3.02 PREPARATION

A. Refer to Section 17050.

B. Coordinate installation with all trades to ensure that the mechanical system has all necessary appurtenances, weldolets, valves, upstream diameters, downstream diameters, etc., for proper installation of the instruments and accessories.

3.03 INSTALLATION

A. Refer to Section 17050.

3.04 FIELD QUALITY CONTROL

A. Refer to Section 17950.

B. Site Test and Inspection:
   1. Perform installed tests in accordance with Section 17050.

3.05 ADJUSTING

A. Calibrate all instruments in accordance with the Manufacturer's instructions.

3.06 CLEANING

A. Refer to Section 17050.

3.07 DEMONSTRATION AND TRAINING

A. Refer to Section 17050.

3.08 PROTECTION

A. Refer to Section 17050.

B. Protect all seals after installation and before commissioning. Replace any seals damaged before commissioning:
   1. The ENGINEER shall be the sole party responsible for determining the corrective measures.

3.09 SCHEDULES

A. The provided information does not necessarily include all required instruments. Furnish all instruments identified on the Contract Drawings or in the Contract Specifications. If an instrument is shown on one of these Documents, it shall be considered to be shown on all.

B. Produce completed Instrument Data Sheets for all instruments required under this Contract:
   1. See Section 17050 for additional requirements.
   2. Submit all Instrument Data Sheets for review.
   3. Instrument Data Sheets shall be furnished in both hard copy and electronic format.

END OF SECTION

SECTION 17402

PRESSURE/VACUUM MEASUREMENT - INSTRUMENT VALVES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes requirements for:
   1. Valve manifolds and instrument valves for permanent installations.

B. Related Sections:
   1. The Contract Documents are a single integrated document, and as such all DIVISIONS and Sections apply. It is the responsibility of the CONTRACTOR and its subcontractors to review all Sections to ensure a complete and coordinated project.

C. Provide all valve manifolds and instrument valves identified on the Drawings and in the specifications.

1.02 REFERENCES

A. Refer to Section 17050.

1.03 DEFINITIONS

A. Refer to Section 17050.

1.04 SUBMITTALS

A. Furnish complete submittals in accordance with Sections 01330 and 17050.

B. Furnish complete Product Data, Shop Drawings, Test Reports, Operating Manuals, Record Drawings, Manufacturer's certifications, Manufacturer's Field Reports, and other submittals as specified in Section 17050, and below.

C. Additional Requirements:
   1. Product Data:
      a. Valve type.
      b. Body material.
      c. Size.
      d. Options.
   2. Shop Drawings:
      a. Mounting details for all manifold valves.

1.05 QUALITY ASSURANCE

A. Manufacture valves at facilities certified to the quality standards of ISO Standard 9001 - Quality Systems - Model for Quality Assurance in Design/Development, Production, Installation, and Servicing.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Refer to Section 17050.

B. Protect valve manifolds and protective coatings from damage during handling and installation. Repair coating where damaged.

1.07 PROJECT OR SITE CONDITIONS

A. Provide instruments suitable for the installed site conditions including, but not limited to, material compatibility, site altitude, site seismic conditions, process and ambient temperature, and humidity conditions.

B. Refer to Section 17050 for project environmental conditions.

1.08 WARRANTY

A. Refer to Section 17050.

1.09 MAINTENANCE

A. Provide all parts, materials, etc. necessary for maintenance and calibration purposes throughout the warranty period. Deliver all of these supplies before project substantial completion.

B. Provide additional spare parts and spare instruments as specified in Section 17050.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Valve Manifold Manufacturers: One of the following:
   1. Anderson Greenwood.
   2. Hex Valve.
   3. Noshok.
   4. Rosemount.

B. Block and Bleed Valve Manufacturers: One of the following:
   1. Anderson Greenwood.
   2. Hex Valve.

C. Gauge Valve Manufacturers: One of the following:
   1. Anderson Greenwood.
   2. Hex Valve.

2.02 MANUFACTURED UNITS

A. Valve Manifolds:
   1. General:
      a. Provide 2-Valve, 3-valve, blowdown type 5-valve, or metering type 5-valve manifolds as indicated on the Drawings.

b. Valve manifolds shall have one-piece bonnet with a metal to metal seal to the valve body below the bonnet threads.
c. Bonnet lock pin to prevent accidental loosening.
d. Gas leak tested metal-to-metal hard seat design for hard seat valves.
e. Gas leak tested soft seat design with replaceable seat for soft seat valves.
f. Manifold valves shall have straight through portion for bi-directional flow and easy roddable cleaning.
g. Manifold valves shall allow for direct or remote instrument mounting.
h. Shall be able to withstand pressures up to 6,000 psi for soft seat valves and 10,000 psi for hard seat valves at maximum 200 degrees Fahrenheit.

2. Materials of Construction:
   a. Body Material: 316 Stainless Steel.
   b. O-Ring: Teflon.
3. 2-Valve Manifolds:
   a. 1 isolation valve and 1 drain/vent and calibration valve.
4. 3-Valve Manifolds:
   a. 2 isolation valves and 1 equalizing valve for differential pressure applications.
   b. Plugged vent connections used for vent/drain or calibration.
5. Blowdown 5-Valve Manifold:
   a. 2 isolation valves, 1 equalizing valve, 2 blowdown valves for differential pressure applications.
6. Metering 5-Valve Manifold (where required):
   a. 2 isolation valves, 2 equalizing valves, 1 vent/drain and calibration valve for differential pressure applications.

B. Block and Bleed Valves:
1. General:
   a. Valve shall provide process isolation and venting/draining capabilities.
   b. Gas leak tested metal-to-metal hard seat design for hard seat valves.
   c. Gas leak tested soft seat design with replaceable seat for soft seat valves.
2. Materials of Construction:
   a. Body Material: 316 Stainless Steel.
   b. O-Ring: Teflon

C. Gauge Valves:
1. General:
   a. Valve shall provide process isolation from pressure instrument.
   b. Gas leak tested metal to metal hard seat design for hard seat valves.
   c. Gas leak tested soft seat design with replaceable seat for soft seat valves.
2. Materials of Construction:
   a. Body Material: 316 Stainless Steel
   b. O-Ring: Teflon.

2.03 ACCESSORIES

A. Provide tube fitting, female NPT, or pipe butt weld connections if necessary.

B. Provide stainless steel concentric or eccentric pipe nipples when necessary.

C. Provide sun shield for outdoor installations.

2.04 SOURCE QUALITY CONTROL

A. Refer to Section 17050 and noted herein.

B. Factory calibrate each analyzer at a facility that is traceable to the National Institute of Testing Standards (NIST).

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine the complete set of Drawings, the process fluids, pressures, and temperatures and furnish instrument valves that are compatible with installed process condition.

B. Examine the installation location for the instrument valve and verify that the instrument valve will work properly when installed.

C. Notify the ENGINEER promptly if any installation condition does not meet the instrument valve manufacturer's recommendations or specifications.

3.02 PREPARATION

A. Refer to Section 17050.

3.03 INSTALLATION

A. Refer to Section 17050.

B. Install according to pressure instrument manufacturer's and instrument valve manufacturer's recommendations and instrumentation or mechanical typical installation details.

3.04 FIELD QUALITY CONTROL

A. Refer to Section 17950.

B. Site Test and Inspection:
   1. Perform installed tests in accordance with Section 17050.

C. Demonstrate the performance of all instruments to the ENGINEER before commissioning.

D. ENGINEER to witness all instrument calibration verification in the field.

E. Each instrument shall be tested before commissioning and the ENGINEER shall witness the response in the PLC control system and associated registers.

3.05 ADJUSTING

A. Verify factory calibration of all instruments in accordance with the Manufacturer's instructions:
   1. Return factory calibrated devices to the factory if they do not meet the field verification requirements for calibration.

B. Adjust valves fully open after installation.

3.06 CLEANING

A. Refer to Section 17050.

3.07 DEMONSTRATION AND TRAINING

A. Refer to Section 17050.

3.08 PROTECTION

A. Refer to Section 17050.

B. All instruments shall be fully protected after installation and before commissioning. The CONTRACTOR shall replace any instruments damaged before commissioning:
   1. The ENGINEER shall be the sole party responsible for determining the corrective measures.

3.09 SCHEDULES

A. The provided information does not necessarily include all required instruments. Furnish all instruments identified on the Contract Drawings or in the Contract Specifications. If an instrument is shown on one of these Documents, it shall be considered to be shown on all.

B. Produce completed Instrument Data Sheets for all instruments required under this Contract:
   1. See Section 17050 for additional requirements.
   2. Submit all Instrument Data Sheets for review.
   3. Instrument Data Sheets shall be furnished in both hard copy and electronic format.

END OF SECTION

SECTION 17403

PRESSURE/VACUUM MEASUREMENT - SWITCHES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes requirements for:
   1. Pressure/vacuum switch instruments.

B. Provide all instruments identified in the Contract Documents.

1.02 REFERENCES

A. Refer to Section 17050.

1.03 DEFINITIONS

A. Refer to Section 17050.

1.04 SUBMITTALS

A. Furnish submittals in accordance with Sections 01330 and 17050.

B. Additional Requirements:
   1. Complete ISA Data Sheet for each specific instrument and submit with all required submittal data.
   2. Product Data:
      a. Accessories such as diaphragm seals, valve manifold, snubbers, and pulsation dampeners.

1.05 QUALITY ASSURANCE

A. Refer to Section 17050.

B. Examine the complete set of Contact Documents and verify that the instruments are compatible with the installed conditions including:
   1. Process conditions: Fluids, pressures, temperatures, flows, materials, etc.
   2. Physical conditions:
      a. Installation and mounting requirements.
      b. Location within the process.
      c. Accessories: Verify that all required accessories are provided and are compatible with the process conditions and physical installation.

C. Notify the ENGINEER if any installation condition does not meet the instrument manufacturer's recommendations or specifications.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Refer to Section 17050.

1.07 PROJECT OR SITE CONDITIONS

A. Refer to Section 17050.

1.08 WARRANTY

A. Refer to Section 17050.

1.09 MAINTENANCE

A. Refer to Section 17050.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Mechanical Type Pressure Switch: One of the following or equal:
   1. Ashcroft B Series Type 400.
   2. United Electric Controls 400 Series.
   3. ASCO S-Series

2.02 MANUFACTURED UNITS

A. Mechanical Type Pressure Switches:
   1. General:
      a. Pressure switch shall be diaphragm or diaphragm-sealed piston type.
   2. Performance requirements:
      a. Pressure Range: As specified in instrument list or schedule.
      b. Accuracy:
         1) ±1.0 percent of range.
      c. Repeatability:
         1) ±1.0 percent of range.
   3. Element:
      a. Type: Diaphragm, diaphragm-sealed piston, or bourdon tube.
      b. Overpressure:
         1) Minimum 150 percent of maximum range pressure without damage to switch or sensing element.
         2) Minimum 400 percent of nominal range without leakage or rupture.
      c. Sensing element shall not require ambient temperature compensation.
      d. Wetted Materials: Stainless steel.
      e. Setpoint:
         1) Single.
         2) Switch shall activate at setpoint on increasing pressure for high-pressure alarm applications and on decreasing pressure for low-pressure alarm applications.
      f. Fixed deadband.
      g. Switch elements:
         1) Snap acting.
         2) Single pole-double throw (SPDT)
         3) Rated at 10A, 125/250VAC.
         4) Automatic reset or Manual reset type as indicated on the Instrument Schedule.

h. Enclosure: Epoxy coated NEMA 4X.
i. Switch Mounting:
1) Process connection: 1/2-inch NPT.

4. Components:
a. Provide all necessary hardware for pressure switch mounting.

2.03 ACCESSORIES

A. Pulsation Dampeners and Snubbers:
1. Provide pulsation dampener or snubber with each pressure switch installed on discharge of positive displacement type pump.
2. Materials: Stainless Steel.
3. Mount pulsation dampener or snubber integrally to the pressure switch.
4. Connection: 1/4-inch NPT.

B. Provide diaphragm seals as specified in instrument list or schedule indicated on the Drawings and as specified in Section 17401:
1. Diaphragm seal and pressure switch shall be assembled by Manufacturer and shipped as an assembly.

C. Furnish block and bleed valves as specified in Section 17402.

2.04 SOURCE QUALITY CONTROL

A. Refer to Section 17050.

B. Factory calibrate each instrument at a facility that is traceable to the National Institute of Standards and Technology (NIST).

PART 3 EXECUTION

3.01 INSTALLATION

A. Refer to Section 17050.

B. Coordinate the installation with all trades to ensure that the mechanical system has all necessary appurtenances including weld-o-lets, valves, etc., for proper installation of instruments.

3.02 FIELD QUALITY CONTROL

A. Refer to Section 17050.

B. Provide manufacturer's services to perform start-up and calibration or verification.

3.03 ADJUSTING

A. Verify factory calibration of all instruments in accordance with the manufacturer's instructions:
1. Return factory calibrated devices to the factory if they do not meet the field verification requirements for calibration.

3.04 CLEANING

A. Refer to Section 17050.

3.05 DEMONSTRATION AND TRAINING

A. Refer to Section 17050.

B. Demonstrate performance of all instruments to the ENGINEER before commissioning.

C. Furnish 8 hours of OWNER training.

3.06 PROTECTION

A. Refer to Section 17050.

3.07 SCHEDULES

A. The provided information does not necessarily include all required instruments. Provide all instruments identified in the Contract Documents:
   1. Instruments may be shown on the Drawings, in the Specifications or both.

A/E: Carollo Engineers	PRESSURE SWITCHES					
					Spec. No.	Rev.
Contractor:	No	By	Date	Revision		
Project:					Contract	Date
Customer:						
Plant:					Req.	P.O.
Location:						
BOM No.:					By / Chk / App	
File:						

	1	Type		Press: Vacuum: Comp.: Diff.Press: Other	
D	2	Setting		Set in Field: Factory Set: Internal: External: Dial:	
E	3	Dead Band		Fixed: Adj.: Min.: Other:	
V	4	Mtl :	Body / Seat / Tube		
I	5	Element Type		Diaphragm: Bourdon: Bellows: Other	
C	6	Material		Bronze: B. SS: Alloy St.: Other	
E	7	Connection		½ in NPT √ Bottom: Back:	
	8	Mounting		Local: Surface: Flush:	
	9	Accuracy			
	10	Other			
	11	Type		Mercury: Snap: Other	
	12	Quantity		Single: Dual: Other	
S	13	Form		SPST: SPDT: DPDT: Other	
W	14	Rating:	Amps / Volts / Hertz	10 / 120 / 60	
I	15	Other			
T	16	D. Load		E. Inductive: Non-Inductive: √	
C	17	Enclosure		General Purpose: Weatherproof: None: Explosion proof:	
H	18	Enclosure Class			
	19	Conduit Connection		MFR STD: Other	
	20	Other			
	21	Manufacturer			
	22	Model No.			

Rev	Tag Number	Adj. Range	SP Process	Signal SP	Op. Temp.	P&ID	Service	Notes
	PSL- or PSH-							

Notes:
Refer to Specification 17401 for additional diaphragm seal requirements.
Refer to Specification 17402 for additional instrument valve requirements.

END OF SECTION

SECTION 17404

PRESSURE/VACUUM MEASUREMENT - GAUGES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes requirements for:
   1. Pressure/Vacuum gauges for instrumentation systems for permanent installation.

B. Related Sections:
   1. The Contract Documents are a single integrated document, and as such all DIVISIONS and Sections apply. It is the responsibility of the CONTRACTOR and its subcontractors to review all Sections to ensure a complete and coordinated project.

C. Provide all instruments identified on the P&IDs and Instrument Index

1.02 REFERENCES

A. Refer to Section 17050.

1.03 DEFINITIONS

A. Refer to Section 17050.

1.04 SUBMITTALS

A. Furnish complete submittals in accordance with Sections 01330 and 17050.

B. Furnish complete Product Data, Shop Drawings, Test Reports, Operating Manuals, Record Drawings, Manufacturer's certifications, Manufacturer's Field Reports, and other submittals as specified in Section 17050, and below.

C. Additional Requirements:
   1. Product Data:
      a. Accessories such as diaphragm seals, valve manifold, snubbers, and pulsation dampeners.
   2. Manufacturer's Certification:
      a. Before installation of instruments, provide Manufacturer's certificate stating that instruments shall be suitable for the installed site conditions, as described in Section 17050. Site conditions include, but are not limited to, material compatibility, site altitude, site seismic conditions, process and ambient temperature, humidity, and site specific conditions.

1.05 QUALITY ASSURANCE

A. Manufacture instruments at facilities certified to the quality standards of ISO Standard 9001 - Quality Systems - Model for Quality Assurance in Design/Development, Production, Installation, and Servicing.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Refer to Section 17050.

B. Store all instruments in a dedicated structure with space conditioning to meet the recommended storage requirements provided by the Manufacturer:
   1. Replace any instruments that are not stored in strict conformance with the Manufacturer's recommendation.

1.07 PROJECT OR SITE CONDITIONS

A. Provide instruments suitable for the installed site conditions including, but not limited to, material compatibility, site altitude, site seismic conditions, process and ambient temperature, and humidity conditions.

B. Refer to Section 17050 for project environmental conditions.

1.08 WARRANTY

A. Refer to Section 17050.

1.09 MAINTENANCE

A. Provide all parts, materials, etc., necessary for maintenance and calibration purposes throughout the warranty period. Deliver all of these supplies before project substantial completion.

B. Provide additional spare parts and spare instruments as specified in Section 17050.

C. Spare Instruments: Deliver the following to OWNER:
   1. 1 pressure gauge of each type and range provided.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Manufacturers: One of the following:
   1. Ashcroft 1279.
   2. Wika.
   3. Ametek U.S. Gauge.

2.02 MANUFACTURED UNITS

A. General:
   1. Pressure gauge assembly shall include pressure sensing element, gauge case, and dial mechanism.

B. Performance requirements:
   1. Pressure Range:
      a. As shown on the P&IDs.
   2. Accuracy:
      a. ± 0.5 percent of span after friction errors are eliminated by tapping or vibration.
      b. Maximum allowable friction inaccuracy: 0.5 percent of span.

C. Sensing Element:
   1. Type: Bourdon tube.
   2. Overpressure: Minimum 130 percent of maximum range pressure without damage to gauge or sensing element.
   3. Wetted Materials: Stainless Steel except for applications where Sodium Hypochlorite is the process fluid.

D. Dial Gauge:
   1. Dial Size: 4-1/2 inches.
   2. Dial case material: Stainless Steel
   3. Liquid Filled
   4. Dial face: Gasketed Shatterproof Glass
   5. Connection and Mounting:
      a. Direct mounted and suitable for outdoor installation.
      b. Connection Location: Lower.
      c. 1/2 inch NPT.
      d. Connection Material: Stainless Steel.
   6. Pointer: Externally adjustable.

2.03 ACCESSORIES

A. Pulsation Dampeners and Snubbers:
   1. Provide pulsation dampener or snubber with each pressure gauge installed on discharge of positive displacement type pump.
   2. Provide piston-type snubber if pressure spikes will exceed 130 percent of gauge maximum range.
   3. Materials: Stainless Steel.
   4. Mount pulsation dampener or snubber integrally to the pressure gauge.
   5. Connection: 1/2-inch NPT.

B. Provide integral diaphragm seals as indicated on the Drawings and as specified in Section 17401:
   1. Diaphragm seal and pressure gauge shall be assembled by Manufacturer and shipped as an assembly.

C. Furnish gauge valves as specified in Section 17402.

D. Provide sun shield for outdoor installations.

2.04 SOURCE QUALITY CONTROL

A. Refer to Section 17050 and noted herein.

B. Factory calibrate each pressure gauge at a facility that is traceable to the National Institute of Standards and Technology (NIST).

C. Provide complete documentation covering the traceability of all calibration instruments.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine the complete set of Drawings, the process fluids, pressures, and temperatures and furnish instruments that are compatible with installed process condition.

B. Examine the installation location for the instrument and verify that the instrument will work properly when installed.

C. Notify the ENGINEER promptly if any installation condition does not meet the instrument Manufacturer's recommendations or specifications.

3.02 PREPARATION

A. Refer to Section 17050.

3.03 INSTALLATION

A. Refer to Section 17050.

B. Install with face of the gauge in the vertical position.

3.04 FIELD QUALITY CONTROL

A. Refer to Section 17950.

B. Site Test and Inspection:
   1. Install in accordance with Manufacturer's requirements.

C. The calibration for each pressure gauge shall be field verified with calibration using test equipment that is traceable to the National Institute of Standards and Technology.

D. Demonstrate the performance of all instruments to the ENGINEER before commissioning.

E. ENGINEER to witness all instrument calibration verification in the field.

F. Each instrument shall be tested before commissioning and the ENGINEER shall witness the response in the PLC control system and associated registers.

3.05 ADJUSTING

A. Verify factory calibration of all instruments in accordance with the Manufacturer's instructions:
   1. Return factory calibrated devices to the factory if they do not meet the field verification requirements for calibration.

3.06 CLEANING

A. Refer to Section 17050.

3.07 DEMONSTRATION AND TRAINING

A. Refer to Section 17050.

3.08 PROTECTION

A. Protect all instruments after installation and before commissioning. Replace any instruments damaged before commissioning:
   1. The ENGINEER shall be the sole party responsible for determining the corrective measures.

3.09 SCHEDULES

A. The provided information does not necessarily include all required instruments. Furnish all instruments identified on the Contract Drawings or in the Contract Specifications. If an instrument is shown on one of these Documents, it shall be considered to be shown on all.

B. Produce completed Instrument Data Sheets for all instruments required under this Contract:
   1. See Section 17050 for additional requirements.
   2. Submit all Instrument Data Sheets for review.
   3. Instrument Data Sheets shall be furnished in both hard copy and electronic format.

END OF SECTION

SECTION 17505

ANALYZERS – RESIDUAL CHLORINE

PART 1 GENERAL

1.01 SUMMARY

A. Section includes requirements for:
   1. Residual chlorine analyzers.

B. Provide all instruments identified in the Contract Documents.

1.02 REFERENCES

A. Refer to Section 17050.

1.03 DEFINITIONS

A. Refer to Section 17050.

1.04 SUBMITTALS

A. Furnish submittals in accordance with Sections 01330 and 17050.

1.05 QUALITY ASSURANCE

A. Refer to Section 17050.

B. Examine the complete set of Contact Documents and verify that the instruments are compatible with the installed conditions including:
   1. Process conditions: Fluids, pressures, temperatures, flows, materials, etc.
   2. Physical conditions:
      a. Installation and mounting requirements.
      b. Location within the process.
      c. Accessories: Verify that all required accessories are provided and are compatible with the process conditions and physical installation.

C. Notify the ENGINEER if any installation condition does not meet the instrument manufacturer's recommendations or specifications.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Refer to Section 17050.

1.07 PROJECT OR SITE CONDITIONS

A. Refer to Section 17050.

1.08 WARRANTY

A. Refer to Section 17050.

1.09 MAINTENANCE

A. Refer to Section 17050.

B. Furnish all parts, materials, fluids, etc. necessary for maintenance and calibration purposes for a period of one year:
   1. Deliver all supplies for substantial completion.

C. Provide the following:
   1. Spare tubing, caps, funnels, fittings for each analyzer, in order to perform recommended maintenance for 1 year.
   2. Three spare membranes for each sensor.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Amperometric Residual Analyzers:
   1. One of the following:
      a. Analytical Technology, Inc.
         1) Combined Chlorine Monitor Model Q45H-63-2-1-1.

2.02 MANUFACTURED UNITS

A. Amperometric Residual Analyzers:
   1. General:
      a. Residual chlorine analyzer utilizing amperometric technology for continuous monitoring of the free chlorine residual in solution.
   2. Performance requirements:
      a. Continuous online analysis for free or total chlorine residual.
      b. Minimum Detection: 0.040 mg/L.
      c. Accuracy:
         1) ±5 percent of reading or ±0.035 mg/L.
      d. Range:
         1) 0 to 5 mg/L free or total residual.
      e. Repeatability:
         1) ±5 percent or 0.005 mg/L.
   3. Components:
      a. Flow through sensors, including flow rate control, multiple probes.
   4. Transmitter:
      a. Power supply:
         1) 120 VAC.
         2) Power consumption: 95 VA maximum.
      b. Outputs:
         1) One 4-20mA isolated output with span programmable over any portion of the chlorine residual range.
         2) Relay Outputs:
            a) Two SPST relay contacts.

b) Selectable to activate on the following conditions:
(1) High or low sample concentration.
(2) Analyzer system warning.
(3) Analyzer system shutdown.
3) Components:
a) Manufacturer's cables.
c. Microprocessor-based signal converter/transmitter.
d. Display:
1) LCD, 2-line.
e. Enclosure:
1) NEMA 4X.

2.03 ACCESSORIES

A. Provide sun shield for outdoor installations.

2.04 SOURCE QUALITY CONTROL

A. Refer to 17050.

B. Provide complete documentation covering the traceability of all calibration instruments.

C. Submit a real-time computer generated printout of the actual calibration data indicating apparent and actual residuals at 20 percent, 40 percent, 60 percent, 80 percent and 100 percent of the calibrated range to the ENGINEER at least 30 days before shipment of the meters to the project site.

PART 3 EXECUTION

3.01 INSTALLATION

A. Refer to Section 17050.

B. Coordinate the installation with all trades to ensure that the mechanical system has all necessary appurtenances including weld-o-lets, valves, etc., for proper installation of instruments.

3.02 FIELD QUALITY CONTROL

A. Refer to Section 17050.

B. Provide manufacturer's services to perform start-up and calibration or verification.

3.03 ADJUSTING

A. Verify factory calibration of all instruments in accordance with the manufacturer's instructions:
1. Return factory calibrated devices to the factory if they do not meet the field verification requirements for calibration.

3.04 CLEANING

A. Refer to Section 17050.

3.05 DEMONSTRATION AND TRAINING

A. Refer to Section 17050.

B. Demonstrate performance of all instruments to the ENGINEER before commissioning.

C. Furnish 8 hours of OWNER training.

3.06 PROTECTION

A. Refer to Section 17050.

3.07 SCHEDULES

A. The provided information does not necessarily include all required instruments. Provide all instruments identified in the Contract Documents:
   1. Instruments may be shown on the Drawings, in the Specifications or both.

A/E: Carollo Engineers					CHLORINE RESIDUAL ANALYZERS					
									Spec. No.	Rev.
Contractor:					No	By	Date	Revision		
Project:									Contract	Date
Customer:										
Plant:									Req.	P.O.
Location:										
BOM No.:									By	Chk App
File:										

G	1	Tag No. | Sample Unit | Transmitter		AE/AIT-	
E	2	Service		Residual Chlorine	
N	3	P&ID			
S	4	Type		[Amperometric] [Colorimetric]	
M	5	Enclosure		NEMA 4X	
P	6	Sampling Method		Slip Stream	
L	7	Operating Temperature Range		35-120 degrees F	
	8	Sample Temperature Range		40-80 degrees F	
U	9	Sample Flow Required		200 - 500 mL/min	
N	10	Manufacturer			
I	11	Model No.			
T	12	Other			
C	13	Style		N/A	
A	14	Length			
B	15	Model No.			
L	16	Other			
E	17	Other			
	18	Type		Control Unit and Display	
T	19	Enclosure		NEMA 4X	
R	20	Mounting			
A	21	Accuracy		[0.02 PPM or 0.5% of F.S.] [+/- 5%]	
N	22	Range			
S	23	Power Requirements		115 VAC, 60 HZ	
M	24	Display		LCD	
I	25	Resolution			
T	26	Output		4-20 mA	
T	27	Calibration			
E	28	Manufacturer			
R	29	Model No.			
	30	Other			
	31	Other			
	32	Other			
	33				
O	34				
P	35				
T	36				
S	37				
	38				

Notes:

END OF SECTION

SECTION 17720

CONTROL SYSTEMS – PROGRAMMABLE LOGIC CONTROLLERS HARDWARE

PART 1 GENERAL

1.01 SUMMARY

A. Section includes requirements for:
   1. Programmable Logic Controller (PLC) based control systems hardware.

B. Related Sections:
   1. Contract Documents are a single integrated document, and as such all Divisions and Sections apply. It is the responsibility of the CONTRACTOR and its Subcontractors to review all Sections to ensure a complete and coordinated project.

1.02 REFERENCES

A. Refer to Section 17050.

1.03 DEFINITIONS

A. Refer to Section 17050.

B. Specific Definitions:
   1. CPU: Central Processing Unit.
   2. I/O: Input/Output.
   3. ICSC: Instrumentation and Control System Contractor.

1.04 SYSTEM DESCRIPTION

A. Provide all PLC hardware as indicated on the Drawings and in this specification.

1.05 SUBMITTALS

A. Furnish submittals in accordance with Section 17050.

B. Product Data:
   1. I/O Modules:
      a. Type.
      b. Standard wiring diagram.

C. Calculations:
   1. Submit calculations to verify that spare I/O requirements of this Section are met.

1.06 QUALITY ASSURANCE

A. Provide PLC hardware manufactured at facilities certified to the quality standards of ISO Standard 9001 - Quality Systems - Model for Quality Assurance in Design/Development, Production, Installation, and Servicing.

B. Additional Requirements:
   1. Provide PLC system components by a single Manufacturer:
      a. Third-party communication modules may be used only for communication or network media functions not provided by the PLC manufacturer.
   2. Use PLC Manufacturer approved hardware, such as cable, mounting hardware, connectors, enclosures, racks, communication cable, splitters, terminators, and taps.
   3. All PLC hardware, I/O devices, and communication devices shall be new, free from defects and produced by Manufacturers regularly engaged in the manufacture of these products.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Refer to Section 17050.

1.08 PROJECT OR SITE CONDITIONS

A. Refer to Section 17050.

1.09 WARRANTY

A. Refer to Section 17050.

1.10 MAINTENANCE

A. Refer to Section 17050.

B. Installed Spare Requirements:
   1. I/O Points:
      a. 25 percent spare capacity for each type of I/O signal at each PLC or RIO. Calculate the spare capacity as the number of unused points on existing I/O modules for the given I/O type divided by the total number of points on existing I/O modules for given I/O type.
      b. Wire all spare I/O points to field terminal blocks in the PCM.
      c. Space shall be available in each PLC or RIO enclosure to support the future addition of 100 percent additional spare I/O.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Acceptable Manufacturers:
   1. Modicon.

2.02 EXISTING PRODUCTS

A. Existing PLC: Modicon PC-E984-255.

B. Existing Discrete Input Modules: Modicon DEP216, 115 VAC in.

C. Existing Relay Output Modules: Modicon DAP208, dry contact out.

D. Existing Analog Input Modules: Modicon ADU206, analog in.

E. Existing Analog Output Modules: Modicon DAU204, analog out.

2.03 MANUFACTURED UNITS

A. Programmable Logic Controller:
   1. PLC Input/Output, I/O Modules:
      a. General:
         1) Compatible with all of the PLCs being furnished under the contract and by the same Manufacturer as the PLCs.
         2) Provide I/O modules that:
            a) Isolated and conform to IEEE Surge Withstand Standards and NEMA Noise Immunity Standards.
            b) Provide A/D and D/A converters with optically or galvanically isolated inputs and outputs.
            c) Accept dual ended inputs.
         3) The commoning of grounds between I/O points is not acceptable.
         4) Modules that are removable without having to disconnect wiring from the module's terminals:
            a) Utilize a swing-arm or plug-in wiring connector.
         5) Provide at each PLC location the I/O modules required to provide the I/O points, including designated future I/O points, contained in the I/O Lists and/or shown on the P&IDs, control schematics, or described in the control strategies:
            a) Provide at each PLC location an installed spare capacity in accordance with the requirements of this Section.
            b) Wire all spares provided to the field terminal strip.
         6) Condition, filter, and check input signals for instrument limit conditions.
         7) Filter, scale, and linearize the raw signal into an engineering units based measurement.
         8) Alarm measurements for high, low, rate-of-change limits, and alarm trends.
         9) Provide external fuses mounted on the field connection terminal block for all discrete input, discrete output, and analog input I/O points.
      b. Discrete Input Modules:
         1) Defined as contact closure inputs from devices external to the input module.
         2) Provide inputs that are optically isolated from low energy common mode transients to 1500 volts peak from users wiring or other I/O Modules.
         3) Individually isolated inputs.
         4) With LED's to indicate status of each discrete input.

5) Input signal level: 120 VAC.
6) Provide input module points that are individually fused with blown fuse indicator lights, mounted external of the module on the output terminal strip:
   a) Coordinate external fuse size with the protection located on the module, so that the external fuse opens first under a fault condition.

c. Discrete Output Modules:
1) Defined as contact closure outputs for ON/OFF operation of devices external to the output module:
   a) Triac outputs may be used, with the permission of the ENGINEER, care must be used in applying this type of modules to ensure that the leakage current through the output device does not falsely signal or indicate an output condition.
2) Optically isolated from inductively generated, normal mode and low energy, common mode transients to 1500 volts peak.
3) LED's to indicate status of each output point.
4) Each output point: Individually isolated.

d. Analog Input Modules:
1) Signal Type: 4 to 20 mA DC.
2) Analog to digital conversion: Minimum 12-bit precision with the digital result entered into the processor.
3) The analog to digital conversion updated with each scan of the processor.Individually isolated each input.Provide individually fused analog input module points with blown fuse indicator lights, mounted external of the module on the output terminal strip:
   a) Coordinate the size of the external fuse with the protection located on the module, so that the external fuse opens first under a fault condition.

e. Analog Output Modules:
1) Signal Type: 4 to 20 mA DC.
2) Individual isolated output points each rated for loads of up to 1200 Ohms.

B. Programming:
1. Refer to Section 17050.

2.04 SOURCE QUALITY CONTROL

A. As specified in Section 17050.

PART 3 EXECUTION

3.01 INSTALLATION

A. Refer to Section 17050.

B. Utilize personnel to accomplish, or supervise the physical installation of all elements, components, accessories, or assemblies:
1. Employ installers who are skilled and experienced in the installation and connection of all elements, components, accessories, and assemblies.

C. All components of the control system including all data network cables are the installation responsibility of the ICSC unless specifically noted otherwise.

3.02 FIELD QUALITY CONTROL

A. Refer to Section 17050.

3.03 CLEANING

A. Refer to Section 17050.

3.04 DEMONSTRATION AND TRAINING

A. As specified in Section 17050.

3.05 PROTECTION

A. Refer to Section 17050.

END OF SECTION

SECTION 17901

SCHEDULES - FIELD INSTRUMENTS

PART 1 GENERAL

1.01 SUMMARY

A. The Schedules Field Instrument is not a take-off list. Refer to Drawings and Specifications for additional information. Where any discrepancies between this list and the P&ID drawings arise, the P&ID shall govern.

B. Abbreviations used in the Instrument Index are defined on the Drawings.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

3.01 SCHEDULES FIELD INSTRUMENTS

A. Schedules Field Instruments attached.

END OF SECTION

SECTION 17903

SCHEDULES - I/O LIST

PART 1 GENERAL

1.01 SUMMARY

A. The I/O list is not a take-off list. Refer to Drawings and Specifications for additional information. Where any discrepancies between this list and the P&ID drawings arise, the P&ID shall govern.

B. Abbreviations used in the I/O list are defined on the Drawings.

PART 2 PRODUCTS

A. Not Used

PART 3 EXECUTION

3.01 I/O LIST

A. I/O list attached.

END OF SECTION