

CONTRACT DOCUMENTS FOR
CONSTRUCTION OF
**SOUTH FAYETTE
WATER TREATMENT PLANT
CHLORINE DIOXIDE
GENERATION SYSTEM**



PREPARED FOR
**FAYETTE COUNTY WATER SYSTEM
FAYETTE COUNTY, GEORGIA**

VOLUME 1 OF 2
SPECIFICATIONS

For information regarding this project, contact:

NATASHA DUGGAN,
FAYETTE COUNTY
PURCHASING DEPARTMENT
140 STONEWALL AVE. W., SUITE 204
FAYETTEVILLE, GA 30214
nduggan@fayettecountyga.gov



Project No.
698133

AUGUST 2019

BID DOCUMENTS

FAYETTE COUNTY WATER SYSTEM

FAYETTE COUNTY, GEORGIA

**BIDDING REQUIREMENTS
AND
CONTRACT DOCUMENTS**

for the construction of the

**SOUTH FAYETTE WATER TREATMENT PLANT
CHLORINE DIOXIDE GENERATION SYSTEM**

CH2M HILL
ATLANTA, GA
AUGUST 2019

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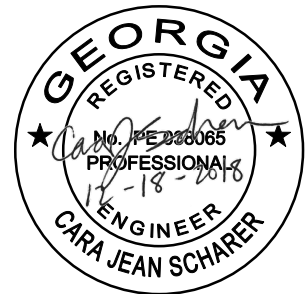
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PART 1

PROCUREMENT REQUIREMENTS



Purchasing Department

140 Stonewall Avenue West, Ste 204
Fayetteville, GA 30214
Phone: 770-305-5420
www.fayettecountyga.gov

August 22, 2019

Subject: Invitation to Bid #1598-B: South Fayette Water Treatment Plant Chlorine Dioxide Generation System

Gentlemen/Ladies:

Fayette County, Georgia is seeking bids for a contract from qualified firms to construct and install a new chlorine dioxide generation system at the South Fayette Water Treatment Plant, in accordance with the information and specifications contained herein.

A mandatory pre-bid conference will be held at 9:00 a.m., Friday, September 20, 2019, at the South Fayette Water Treatment Plant, 880 Antioch Road in Fayetteville, GA 30215. All companies and interested parties are invited and strongly urged to attend. This will be the opportunity to take measurements, pictures, voice all questions, concerns and comments about this Invitation to Bid and have them addressed. Firms that attend the conference will be authorized to submit bids.

Questions concerning this invitation to bid should be addressed to Natasha Duggan, Contract Administrator in writing via email to nduggan@fayettecountyga.gov or fax to (770) 719-5534. Questions will be accepted until 3:00 pm, Friday, September 27, 2019.

The Purchasing Department office hours are Monday through Friday 8:00 a.m. to 5:00 p.m. excluding holidays. The office telephone number is (770) 305-5420.

Bids will be received at the address below until 3:00 p.m., Friday, October 4, 2019 in the Purchasing Department, Suite 204. Bids will be opened at that time. Bids must be signed to be considered. Late bids will not be considered. Faxed or emailed bids will not be considered.

Please submit your bids to the following address:

Fayette County Purchasing Department
140 Stonewall Avenue West, Suite 204
Fayetteville, Georgia 30214

Bid Number: 1598-B

Bid Name: South Fayette Water Treatment Plant Chlorine Dioxide Generation

Your bid should be on the Bid Form included herein. All prices shall be F.O.B. Destination, Fayette County. Be sure to include the **bid number** and **bid name** along with your company's name and address on the **sealed** envelope in which the bid is returned. Please do not staple the bid pages together.

If you downloaded this Invitation to Bid from the county's website, it will be your responsibility to check the website for any addenda that might be issued for this solicitation. The county cannot not be responsible for a bidder not receiving information provided in any addenda.

Sincerely,

Ted L. Burgess
Director of Purchasing

TLB/nmd

Fayette County, Georgia

CHECKLIST OF REQUIRED DOCUMENTS

***(Be Sure to Return This Checklist and
the Required Documents in the order listed below)***

ITB #1598-B: South Fayette Water Treatment Plant, Chlorine Dioxide Generation System

Contractor Affidavit under O.C.G.A. § 13-10-91(b)(1) _____

Non-Resident: Proof of authority to do business in Georgia (00 11 56.01-2) _____
(Or written covenant to obtain such license)

Company information – on the form provided _____

Bidder's Qualification Form (00 11 56.01 – 1, 2, 3, 4, 5, 6, 7) _____

Affidavit for Individual (00 11 56.01 – 9) _____

Affidavit for Co-partnership (00 11 56.01 – 11) _____

Affidavit for Corporation (00 11 56.01 – 13) _____

Bid Form (00 41 13 – 1, 2, 3, 4, 5, 6, 7) includes Addendum Acknowledgment _____

Bid Bond (00 43 13 – 1, 2) _____

Statement of Non-collusion (00 45 54 – 1) _____

Performance Bond Form (00 61 13.13 – 1, 2, 3, 4) _____

Payment Bond Form (00 61 13.16 – 1, 2, 3, 4) _____

List of exceptions, if any – on the form provided _____

Evidence of Authority to Sign _____

COMPANY NAME: _____

Contractor Affidavit under O.C.G.A. § 13-10-91(b)(1)

By executing this affidavit, the undersigned contractor verifies its compliance with O.C.G.A. § 13-10-91, stating affirmatively that the individual, firm or corporation which is engaged in the physical performance of services on behalf of Fayette County, Georgia has registered with, is authorized to use and uses the federal work authorization program commonly known as E-Verify, or any subsequent replacement program, in accordance with the applicable provisions and deadlines established in O.C.G.A. § 13-10-91. Furthermore, the undersigned contractor will continue to use the federal work authorization program throughout the contract period and the undersigned contractor will contract for the physical performance of services in satisfaction of such contract only with subcontractors who present an affidavit to the contractor with the information required by O.C.G.A. § 13-10-91(b). Contractor hereby attests that its federal work authorization user identification number and date of authorization are as follows:

Federal Work Authorization User Identification Number

Date of Authorization

Name of Contractor

**ITB #1598-B: South Fayette Water Treatment Plant
Chlorine Dioxide Generation System**

Name of Project

FAYETTE COUNTY GEORGIA

Name of Public Employer

I hereby declare under penalty of perjury that the foregoing is true and correct.

Executed on _____, _____, 2019 in (city) _____, (state) _____

Signature of Authorized Officer or Agent

Printed Name and Title of Authorized Officer or Agent

SUBSCRIBED AND SWORN BEFORE ME

ON THIS THE _____ DAY OF _____, 2019.

NOTARY PUBLIC

My Commission Expires:

COMPANY INFORMATION
ITB #1598-B: South Fayette Water Treatment Plant
Chlorine Dioxide Generation System

Company Name: _____

Physical Address: _____

Mailing Address (if different): _____

AUTHORIZED REPRESENTATIVE

Signature: _____

Printed or Typed Name: _____

Title: _____

Email Address: _____

Phone Number: _____ Fax Number: _____

PROJECT CONTACT PERSON

Name: _____

Title: _____

Office Number: _____ Cellular Number: _____

Email Address: _____

Phone Number: _____ Fax Number: _____

The Owner requires prospective Bidders interested in bidding on the Work to provide a completed Bidder's Qualification Form with their Bid. If form is not received with Bid and in accordance with Instructions to Bidders, Bid will be considered nonconforming and nonresponsive.

BIDDER'S QUALIFICATION

Submitted By: _____
 (Bidder) _____
 A Corporation
 A Partnership
 An Individual
 (Circle One)

Principal Office

Physical Address: _____

Mailing Address (If different): _____

Authorized Representative (Print or Type): _____

Authorized Representative (Signature): _____

Title: _____

Email Address: _____

Telephone Number: _____

Fax Number: _____

Cellular Number: _____

If **Corporation**, provide the following:

Date of Incorporation: _____

State of Incorporation: _____

Chief Executive Officer's Name: _____

President's Name: _____

Vice President's Name(s): _____

Secretary's Name: _____

Treasurer's Name: _____

If a **Partnership**, provide the following:

Date of organization: _____

Is partnership general or limited? _____

Name and address of each partner: _____

If an **Individual**, provide the following:

Name and business address: _____

Bidder's Surety:

Firm Name: _____

Address: _____

Telephone Number: _____

Contact Person: _____

Bidder's Bank and Local Contact:

Firm Name: _____

Address: _____

Telephone Number: _____

Contact Person: _____

Bidder's General Information:

Utility and General Contractor License Number: _____

Years in business under license number: _____

If nonresident, proof of authority to do business in the State. Attach with form submission.

Primary type of work your company performs: _____

Number of people permanently employed: _____

Bonding Capacity: \$ _____

Dollar volume presently under Contract: _____

Is this organization an equal employment opportunity employer? _____

Does this organization have a written drug and alcohol policy? _____

What type of scheduling techniques does this organization use, and for how long have you been using them? _____

Does this organization have a written Quality Assurance/Quality Control Program? _____

Bidder's Business References

1. Architect/Engineer:

Firm Name: _____

Address: _____

Telephone Number: _____

Contact Person: _____

Firm Name: _____

Address: _____

Telephone Number: _____

Contact Person: _____

2. Owner:

Company Name: _____

Address: _____

Telephone Number: _____

Contact Person: _____

Company Name: _____

Address: _____

Telephone Number: _____

Contact Person: _____

Bidder's Safety Questionnaire

1. Provide your company's Experience Modification Rate (EMR) for the 3 most recent years.

Year _____ Rate _____

Year _____ Rate _____

Year _____ Rate _____

2. Provide your company's Lost Time Incident (LTIR) for the 3 most recent years.

Year _____ Rate _____

Year _____ Rate _____

Year _____ Rate _____

3. The responsibility of maintaining your company's safety records/accident summaries, is assigned to:

	No	Yes	Annually	Monthly	Weekly
Safety Department					
Personnel					
Q.C. Office					
Insurance Group					
Other					

4. How often are field projects (OSHA 200) and accident reports/summaries sent to:

	Annually	Monthly	Weekly
Company President			
Safety Director			

5. Accident records/summaries totaled by:

	No	Yes	Annually	Monthly	Weekly
Entire Company					
Project					
Supervisor					
Foreman					

6. Accident cost totaled by:

	No	Yes	Annually	Monthly	Weekly
Entire Company					
Project					
Supervisor					
Foreman					

7. Does your company have an ongoing training program for:

	Yes	No
a. HAZ-COM		
b. Electrical Safety		
c. Fire Protection		
d. Emergency Aid Procedures		
e. Emergency Procedures		
f. New Worker Orientation		
g. Proper Use of Personal Protection Equipment		
h. Rigging and Crane Safety		
i. Trenching Safety		

8. Does your company have a written safety program (Yes/No): _____.

9. Do all your company and field projects conduct:

	No	Yes	Annually	Bi-Weekly	Monthly
a. Safety Inspections					
b. Safety Meetings					
c. Supervisor Meetings					
d. Adhoc Investigations					

10. Using your last year's (OSHA 200) log fill in the following:

- a. Number of lost workday cases _____.
- b. Number of restricted workday cases _____.
- c. Number of cases requiring medical treatment _____.
- d. Number of fatalities _____.

Bidder's Experience Questionnaire

- 1. How many years' experience in the proposed type and size of construction work has your organization had: _____
- 2. List the most recent projects your organization has had in construction work similar in type and size to the work proposed herein:

Contract Amount	Type of Work	Date Completed	Owner Name, Address, Telephone, and Contact Person

3. What other projects have your organization completed that may be of interest?

Contract Amount	Type of Work	Date Completed	Owner Name, Address, Telephone, and Contact Person

4. Have you ever failed to complete any work awarded to you? _____. If so, list below and state why? _____

5. Have you ever been removed from a project? _____. If so, list below and state why? _____

6. What is the construction experience of the principal individuals of your organization?

Individual's Name	Present Position or Office	Years of Construction Experience	Magnitude & Type of Work	In What Capacity

7. List the major items of equipment that this organization owns or leases (designate which) which will be available for use on the proposed project:

8. List below the contracts that you, your company, or corporation were party, during the previous 10 years, were involved in litigation of any type:

9. Are there any judgements, claims, arbitration proceedings, or lawsuits pending, outstanding, or threatened to which this organization, or an officer or partner in this organization has been a party? _____
If yes, describe: _____

10. Has company ever been disbarred from Bidding? _____. If so, list below and state why?

11. Has the company ever been denied a bid, performance, or payment bond? _____. If so, list below and state why? _____
12. Has the company ever been involved in bankruptcy proceedings? _____. If so, list below and state why? _____
13. Will you, upon request, fill out a detailed financial statement and furnish any other information that may be required by the Owner? _____

The undersigned hereby declares that the foregoing statements are true.

Dated at _____ this ____ day of _____, 20____.

By _____

Title _____

Date _____

AFFIDAVIT FOR INDIVIDUAL

STATE OF _____ }
 _____ } ss.
 COUNTY OF _____ }

I, _____,
 being duly sworn, depose and say that the foregoing financial statement, taken from my
 books, is a true and accurate statement of my financial condition as of the date thereof, and
 that the answers to the interrogatories contained therein are true; that the statements and
 answers to the interrogatories of the equipment questionnaire are correct and true as of the
 date of this affidavit; and that the statements and answers to the interrogatories of the
 foregoing experience questionnaire are correct and true as of the date of this affidavit.

 (Applicant must also sign here)

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

My commission expires: _____

 _____Notary Public

AFFIDAVIT FOR COPARTNERSHIP

STATE OF _____ }
 _____ } ss.
 COUNTY OF _____ }

I, _____,
 being duly sworn, depose and say that I am a member of the firm of _____

_____ taken from the books of said firm, is a true and accurate statement of the financial condition of said firm as of the date thereof, and that the answers to the interrogatories contained therein are true; that the statements and answers to the interrogatories of the equipment questionnaire are correct and true as of the date of this affidavit; and that the statements and answers to the interrogatories of the foregoing experience questionnaire are correct and true as of the date of this affidavit.

 (Member of firm must also sign here)

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

My commission expires: _____

 _____ Notary Public

AFFIDAVIT FOR CORPORATION

STATE OF _____ }
 _____ } ss.
 COUNTY OF _____ }

I, _____,
 being duly sworn, depose and say that I am _____,
 of the _____,
 the corporation described herein and which executed the foregoing statement; that I am
 familiar with the books of the said corporation showing its financial condition; that the
 foregoing financial statement, taken from the books of said corporation, is a true and accurate
 statement of the financial condition of said corporation as of the date thereof, and that the
 answers to the interrogatories of the equipment questionnaire are correct and true as of the
 date of this affidavit; and that the statements and answers to the interrogatories of the
 foregoing experience questionnaire are correct and true as of the date of this affidavit.

 (Officer must also sign here)

Subscribed and sworn to before me this ____ day of ____, 20 ____.

My commission expires: _____

 Notary Public

END OF SECTION

INSTRUCTIONS TO BIDDERS

1. DEFINED TERMS

1.1. Terms used in these Instructions to Bidders have the meanings indicated in the General Conditions and Supplementary Conditions. Additional terms used in these Instructions to Bidders have the meanings indicated below:

1.1.1. *Issuing Office*—The office from which the Bidding Documents are to be issued and where the bidding procedures are to be administered.

2. COPIES OF BIDDING DOCUMENTS

2.1. Complete sets of the Bidding Documents stated in the Invitation to Bid may be obtained from the Owner's Fayette County website at:

www.fayettecountyga.gov/purchasing/bids_and_proposals.htm

2.2. Complete sets of Bidding Documents shall be used in preparing Bids. Neither Owner nor Engineer assumes responsibility for errors or misinterpretations resulting from use of incomplete sets of Bidding Documents.

2.3. Owner and Engineer, in making copies of Bidding Documents made available on the above terms, do so only for the purpose of obtaining Bids for the Work and do not authorize or confer a license or grant for any other use.

3. QUALIFICATIONS OF BIDDERS

3.1. In order to perform public work, Bidder and its Subcontractors, prior to award of Contract or as otherwise required by the jurisdiction, shall hold or obtain such licenses as required by State Statutes, and federal and local Laws and Regulations.

3.2. Bidder shall submit completed Bidder's Qualification Form with their Bid.

3.3. Bidder is advised to carefully review those portions of the Bid Form requiring representations and certifications.

4. EXAMINATION OF BIDDING DOCUMENTS, OTHER RELATED DATA, AND SITE

4.1. Subsurface and Physical Conditions:

4.1.1. The Supplementary Conditions identify:

4.1.1.1. Those reports known to Owner of explorations and tests of subsurface conditions at or contiguous to the Site.

4.1.1.2. Those drawings known to Owner of physical conditions relating to existing surface and subsurface structures at the Site (except Underground Facilities).

4.1.2. Copies of reports and drawings referenced will be made available by Owner to any Bidder on request. The “technical data” contained therein upon which Bidder is entitled to rely as provided in Paragraph 5.03 of the General Conditions has been identified and established in Paragraph 5.03 of the Supplementary Conditions. Bidder is responsible for any interpretation or conclusion Bidder draws from any “technical data” or any other data, interpretations, opinions, or information contained in such reports or shown or indicated in such drawings. Costs associated with making available copies of reports and drawings shall be borne by Bidder.

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

4.3. Provisions concerning responsibilities for the adequacy of data furnished to prospective Bidders with respect to subsurface conditions, other physical conditions, and Underground Facilities, and possible changes in the Bidding Documents due to differing or unanticipated subsurface or physical conditions appear in Paragraph 5.03 through Paragraph 5.05 of the General Conditions. Provisions concerning responsibilities for the adequacy of data furnished to prospective Bidders with respect to a Hazardous Environmental Condition at the Site, if any, and possible changes in the Contract Documents as a result of any Hazardous Environmental Condition uncovered or revealed at the Site which was not shown or indicated in the Drawings or Specifications or identified in the Contract Documents to be within the scope of the Work, appear in Paragraph 5.06 of the General Conditions.

4.4. On request, Owner will provide each Bidder access to the Site to conduct such examinations, investigations, explorations, tests, and studies as Bidder deems necessary for submission of a Bid. Bidder shall fill all holes and clean up and restore the Site to its former condition upon completion of such explorations, investigations, tests, and studies. Bidder shall comply with all applicable Laws and Regulations relative to excavation and utility locates.

4.5. Safety: Paragraph 7.12.C of the General Conditions indicates that if an Owner safety program exists, it will be noted in the Supplementary Conditions.

4.6. It is responsibility of each Bidder before submitting a Bid to:

4.6.1. Examine and carefully study the Bidding Documents, other related data identified in the Bidding Documents, and any Addenda.

4.6.2. Visit the Site to become familiar with and satisfy Bidder as to the general, local, and Site conditions that may affect cost, progress, and performance of the Work.

4.6.3. Become familiar with and satisfy Bidder as to all federal, state, and local Laws and Regulations that may affect cost, progress, and performance of the Work.

4.6.4. Carefully study all:

4.6.4.1. Reports of explorations and tests of subsurface conditions at or contiguous to the Site and all drawings of physical conditions relating to existing surface or subsurface structures at the Site (except Underground Facilities) that have been identified in Paragraph 5.03 of the Supplementary Conditions as containing reliable “technical data”.

4.6.5. Consider the information known to Bidder; information commonly known to contractors doing business in the locality of the Site; information and observations obtained from visits to the Site; the Bidding Documents; and the Site-related reports and drawings identified in the Bidding Documents, with respect to the effect of such information, observations, and documents on:

4.6.5.1. Cost, progress, and performance of the Work.

4.6.5.2. Means, methods, techniques, sequences, and procedures of construction to be employed by Bidder, including applying any specific means, methods, techniques, sequences, and procedures of construction expressly required by the Bidding Documents.

4.6.5.3. Bidder’s safety precautions and programs.

4.6.6. Agree at the time of submitting its Bid that no further examinations, investigations, explorations, tests, studies, or data are necessary for the determination of its Bid for performance of the Work at the price(s) Bid and within the times required, and in accordance with the other terms and conditions of the Bidding Documents.

4.6.7. Promptly give Engineer written notice of all conflicts, errors, ambiguities, or discrepancies that Bidder discovers in Bidding Documents and confirm that written resolution thereof by Engineer is acceptable to Bidder.

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

4.7. Submission of a Bid will constitute an incontrovertible representation by Bidder that Bidder has complied with every requirement of this article; that without exception the Bid is premised upon performing and furnishing the Work required by Bidding Documents and applying specific means, methods, techniques, sequences, and procedures of construction that may be shown or indicated or expressly required by Bidding Documents; that Bidder has given Engineer written notice of all conflicts, errors, ambiguities, and discrepancies that Bidder has discovered in Bidding Documents and the written resolutions thereof by Engineer are acceptable to Bidder; and that Bidding Documents are generally sufficient to indicate and convey understanding of terms and conditions for performing and furnishing the Work.

5. PREBID CONFERENCE

5.1. A prebid conference will be held at 9:00 a.m. local time on Friday, September 20, 2019 at the South Fayette Water Treatment Plant, 880 Antioch Road in Fayetteville, GA 30215. Representatives of Owner and Engineer will be present to discuss the Project. Bidders are required to attend and participate in the conference. Bids will not be accepted from Bidders that do not have a representative at the prebid conference. Fayette County Purchasing will post on its website to prospective Bidders of record such Addenda as Engineer considers necessary in response to questions arising at the conference. Oral statements may not be relied upon and will not be binding or legally effective.

6. INTERPRETATIONS AND ADDENDA

6.1. All questions about the meaning or intent of the Bidding Documents are to be submitted to Fayette County Purchasing in writing. Interpretations or clarifications considered necessary by Engineer in response to such questions will be issued by Addenda via the website. Questions received less than 7 days prior to the date for opening of Bids may not be answered. Only questions answered by Addenda will be binding. Oral and other interpretations or clarifications will be without legal effect.

6.2. Addenda may also be issued to clarify, correct, or change the Bidding Documents as deemed advisable by Owner or Engineer.

7. BID SECURITY

7.1. Bid shall be accompanied by Bid security made payable to Owner in an amount of 5 percent of Bidder's maximum Bid price and in the form of a certified check,

bank money order, or a penal Bid bond (on the attached form), issued by a surety meeting the requirements of Paragraph 6.01 of the General Conditions.

7.2. The Bid security of the Successful Bidder will be retained until such Bidder has executed the Contract Documents, furnished the required contract security and met the other conditions of the Notice of Award, whereupon the Bid security will be returned. If the Successful Bidder fails to execute and deliver the Contract Documents and furnish the required contract security within the time period specified in Article Signing of Agreement, Owner may consider Bidder to be in default, annul the Notice of Award, and the Bid security of that Bidder will be forfeited. Such forfeiture shall be Owner's exclusive remedy if Bidder defaults. Bid security of other Bidders whom Owner believes to have a reasonable chance of receiving the award may be retained by Owner until the earlier of the 7th day after the Effective Date of the Agreement or the number of days specified for all Bids to remain subject to acceptance in Article Bids to Remain Subject to Acceptance, whereupon Bid security furnished by such Bidders will be returned.

7.3. Bid security of other Bidders whom Owner believes do not have a reasonable chance of receiving the award will be returned within 7 days after Bid opening.

8. CONTRACT TIMES

8.1. The number of days within which, or the dates by which, the Work is to be substantially completed and ready for final payment are set forth in the Agreement.

9. LIQUIDATED DAMAGES

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

10. SUBSTITUTE AND "OR-EQUAL" ITEMS

10.1. The Contract, if awarded, will be on the basis of materials and equipment specified or described in the Bidding Documents without consideration of possible substitute or "or-equal" items. Whenever it is specified or described in the Bidding Documents that a substitute or "or-equal" item of material or equipment may be furnished or used by Contractor if acceptable to Engineer, application for such acceptance will not be considered by Engineer until after the Effective Date of the Agreement. No additional named equipment or suppliers will be added during the Bid period. If a supplier's equipment is in compliance with all requirements of the technical specification, and if the use of substitute or "or-equal" is not excluded from the specification, a supplier may bid his/her equipment to a Bidding Contractor. However, if the equipment is found to be unacceptable during review of submittals, the Contractor shall provide the named equipment/vendor at no additional cost to the Owner.

11. PREPARATION OF BID

11.1. With each copy of the Bidding Documents, Bidder will be furnished one separate unbound copy of the Bid Form, and, if applicable, the Bid Bond Form. No substitution of the Bid Form will be allowed.

11.2. All blanks on the Bid Form shall be completed by typing or printing with ink and the Bid Form signed in ink. Erasures or alterations shall be initialed in ink by the person signing the Bid Form. A Bid price shall be indicated for each Bid item listed therein or the words "No Bid," "No Change," or "Not Applicable" entered.

11.3. A Bid by a corporation shall be executed in the corporate name by the president or a vice president or other corporate officer accompanied by evidence of authority to sign. The corporate seal shall be affixed and attested by the secretary or an assistant secretary. The corporate address and state of incorporation shall be shown.

11.4. A Bid by a partnership shall be executed in the partnership name and signed by a partner (whose title must appear under the signature), accompanied by evidence of authority to sign. The official address of the partnership shall be shown.

11.5. A Bid by a limited liability company shall be executed in the name of the firm by a member and accompanied by evidence of authority to sign. The state of formation of the firm and the official address of the firm shall be shown.

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

11.7. A Bid by a joint venture shall be executed by each joint venturer in the manner indicated on the Bid Form. The official address of the joint venture shall be shown.

11.8. All names shall be typed or printed in ink below the signatures.

11.9. The Bid shall contain an acknowledgement of receipt of all Addenda; the numbers of which shall be filled in on the Bid Form.

11.10. Postal and e-mail addresses and telephone number for communications regarding the Bid shall be shown.

11.11. The Bid shall contain evidence of Bidder's authority and qualification to do business in the state where the Project is located, or Bidder shall covenant in writing to obtain such authority and qualification prior to award of the Contract and attach such covenant to the Bid. Bidder's state contractor license number and class, if applicable, shall also be shown on the Bid Form.

12. BASIS OF BID; COMPARISON OF BIDS

12.1. Lump Sum:

12.1.1. Bidders shall submit a Bid on a lump sum basis as set forth in the Bid Form.

12.2. Allowances:

12.2.1. Cash Allowance:

12.2.1.1. Bid price shall include such amounts as the Bidder deems proper for Contractor's costs for unloading and handling on the Site, labor, installation, overhead, profit, and other expenses on account of cash allowances.

12.2.1.2. As described in the Bid Form, General Conditions Paragraph 13.02, and Section 01 29 00, Payment Procedures.

13. SUBMISSION OF BID

13.1. The unbound copy of the Bid Form is to be completed and submitted with the Bid security and the following data:

13.1.1. Bidder's Experience.

13.1.2. Bidder's Qualification.

13.1.3. List of Project References.

13.1.4. Evidence of authority to do business in the state of the Project; or a written covenant to obtain such license within the time for acceptance of Bids.

13.1.5. Contractor's License No.

13.1.6. Statement of Noncollusion.

13.2. A Bid shall be submitted no later than the date and time prescribed, and at the place indicated in the Invitation to Bid. Enclose Bid in a plainly marked package with the Project title, name and address of Bidder, and accompanied by the Bid security and other required documents. If a Bid is sent by mail or other delivery system, the sealed envelope containing the Bid shall be enclosed in a separate package plainly marked on the outside with the notation "BID ENCLOSED."

14. MODIFICATION AND WITHDRAWAL OF BID

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

14.2. Bids may be withdrawn after the Bid opening only with written authorization from the Director of Purchasing.

15. OPENING OF BIDS

15.1. Bids will be opened at the time and place indicated in the Invitation to Bid and unless obviously nonresponsive, read aloud publicly. An abstract of the amounts of the base Bids will be made available to Bidders after the opening of Bids.

16. BIDS TO REMAIN SUBJECT TO ACCEPTANCE

16.1. All Bids will remain subject to acceptance for the period of time stated in the Bid Form, but Owner may, in its sole discretion, release any Bid and return the Bid security prior to the end of this period.

17. EVALUATION OF BIDS AND AWARD OF CONTRACT

17.1. More than one Bid for the same Work from an individual or entity under the same or different names will not be considered. Reasonable grounds for believing that any Bidder has an interest in more than one Bid for the Work may be cause for disqualification of that Bidder and the rejection of all Bids in which that Bidder has an interest.

17.2. In evaluating Bidders, Owner may consider the qualifications of Bidders and may consider the qualifications and experience of Subcontractors, Suppliers, and other individuals or entities proposed for those portions of the Work for which the identity of Subcontractors, Suppliers, and other individuals or entities must be submitted either with the Bid, or otherwise prior to issuance of the Notice of Award.

17.3. Owner may conduct such investigations as Owner deems necessary to establish responsibility, qualifications, and financial ability of Bidders, proposed Subcontractors, Suppliers, individuals, or entities proposed for those portions of the Work in accordance with the Contract Documents.

17.4. If the Contract is to be awarded, Owner will award the Contract to Bidder whose Bid is in the best interests of the Project.

18. CONTRACT SECURITY AND INSURANCE

18.1. Article 6 of the General Conditions, as may be modified by the Supplementary Conditions, sets forth Owner's requirements as to bonds and insurance. When Successful Bidder delivers executed Agreement to Owner, it shall be accompanied by such bonds.

19. SIGNING OF AGREEMENT

19.1. Pursuant to Code of Georgia 13-10-90 et. seq., the Georgia Security and Immigration Compliance Act of 2006, the following shall be completed prior to Award:

19.1.1. Contractor understands and agrees that compliance with the requirements of OCGA 13-10-90 and Georgia Department of Labor Rule 300-10-02 are conditions of this Agreement.

19.2. Pursuant to Code of Georgia 48-13, nonresident Contractor shall complete the following prior to Award:

19.2.1. Register with Commissioner and pay fee.

19.2.2. Execute and file with Commissioner, bond worth 10 percent of Contract, conditioned that state and local taxes will be paid.

19.2.3. Appoint, in writing, Secretary of State to be lawful agent upon whom all lawful processes, proceedings, or notices may be served.

19.3. When Owner issues a Notice of Award to Successful Bidder, it shall be accompanied by the required number of unsigned counterparts of the Agreement along with the other Contract Documents that are identified in the Agreement as attached thereto. Within 15 days thereafter, Successful Bidder shall sign and deliver the required number of counterparts of the Agreement and attached documents to Owner. Within 10 days thereafter, Owner shall deliver one fully signed counterpart to Successful Bidder with a complete set of the Drawings with appropriate identification.

20. RETAINAGE

20.1. Provisions concerning retainage and Contractor's rights to deposit securities in lieu of retainage, if applicable, are set forth in the Agreement.

END OF SECTION

NOTE TO BIDDER: Use typewriter or ink for completing this Bid Form.

BID FORM

1. BID RECIPIENT

1.1. This Bid is submitted to:

Owner: Fayette County, Georgia

Address: Purchasing Department, Stonewall Ave West
Suite 204, Fayetteville, GA 30214

Project Identification: South Fayette Water Treatment Plant Chlorine Dioxide
Generation System

Bid No.: 1598-B

1.2. The undersigned Bidder proposes and agrees, if this Bid is accepted, to enter into an Agreement with Owner in the form included in the Bidding Documents to perform all Work as specified or indicated in the Bidding Documents for the prices and within the times indicated in this Bid and in accordance with the other terms and conditions of the Bidding Documents.

2. BIDDER'S ACKNOWLEDGEMENTS

2.1. Bidder accepts all of the terms and conditions of the Instructions to Bidders, including without limitation those dealing with the disposition of Bid security. This Bid will remain subject to acceptance for 60 days after the Bid opening, or for such longer period of time that Bidder may agree to in writing upon request of Owner.

3. BIDDER'S REPRESENTATIONS

3.1. In submitting this Bid, Bidder represents that:

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

Addendum No.	Addendum Date

(Bidder shall insert number of each Addendum received.)

3.1.2. Bidder has visited the Site and become familiar with and is satisfied as to the general, local, and Site conditions that may affect cost, progress, and performance of the Work.

3.1.3. Bidder is familiar with and is satisfied as to all Laws and Regulations that may affect cost, progress, and performance of the Work.

3.1.4. Bidder has carefully studied: i) reports of explorations and tests of subsurface conditions at or contiguous to the Site and drawings of physical conditions relating to existing surface or subsurface structures at the Site (except Underground Facilities) which have been identified in Paragraph 5.03 of the Supplementary Conditions as containing reliable "technical data,"; and ii) reports and drawings of Hazardous Environmental Conditions, if any, at the Site that have been identified in Paragraph 5.06 of the Supplementary Conditions as containing reliable "technical data."

3.1.5. Bidder has considered the information known to Bidder; information commonly known to contractors doing business in the locality of the Site; information and observations obtained from visits to the Site; the Bidding Documents; and the Site-related reports and drawings identified in the Bidding Documents, with respect to the effect of such information, observations, and documents on (1) the cost, progress, and performance of the Work; (2) the means, methods, techniques, sequences, and procedures of construction to be employed by Bidder, including applying the specific means, methods, techniques, sequences, and procedures of construction expressly required by the Bidding Documents; and (3) Bidder's safety precautions and programs.

3.1.6. Based on information and observations referred to in paragraph above, Bidder does not consider that further examinations, investigations, explorations, tests, studies, or data are necessary for the determination of this Bid for performance of the Work at the price(s) Bid and within the times required, and in accordance with the other terms and conditions of the Bidding Documents.

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

3.1.8. Bidder has given Engineer written notice of conflicts, errors, ambiguities, or discrepancies that Bidder has discovered in the Bidding Documents, and the written resolution thereof by Engineer is acceptable to Bidder.

3.1.9. The Bidding Documents are generally sufficient to indicate and convey understanding of terms and conditions for the performance of the Work for which this Bid is submitted.

4. BIDDER'S CERTIFICATION

4.1. Bidder certifies:

4.1.1. This Bid is genuine and not made in the interest of or on behalf of any undisclosed individual or entity and is not submitted in conformity with any collusive agreement or rules of any group, association, organization or corporation;

4.1.2. Bidder has not directly or indirectly induced or solicited any other Bidder to submit a false or sham Bid;

4.1.3. Bidder has not solicited or induced any individual or entity to refrain from bidding; and

4.1.4. Bidder has not engaged in corrupt, fraudulent, collusive, or coercive practices in competing for the Contract. For the purposes of this paragraph:

4.1.4.1. "corrupt practice" means the offering, giving, receiving, or soliciting of anything of value likely to influence the action of a public official in the bidding process;

4.1.4.2. "fraudulent practice" means an intentional misrepresentation of facts made (a) to influence the bidding process to the detriment of Owner, (b) to establish Bid prices at artificial noncompetitive levels, or (c) to deprive Owner of the benefits of free and open competition;

4.1.4.3. "collusive practice" means a scheme or arrangement between two or more Bidders, with or without the knowledge of Owner, a purpose of which is to establish Bid prices at artificial, noncompetitive levels; and

4.1.4.4. "coercive practice" means harming or threatening to harm, directly or indirectly, persons or their property to influence their participation in the bidding process or affect the execution of the Contract.

4.1.5. Required sales and use taxes are included in the stated Bid prices for the Work unless provision is made herein for the Bidder to separately itemize the estimated amount of sales tax or if Instructions to Bidders state Owner is tax exempt.

5. BASIS OF BIDS

5.1. Bidder shall complete the Work in accordance with the Contract Documents for the following price(s):

5.2. Lump Sum Bid Price: \$_____

5.3. Cash Allowance(s):

Item	Description	Allowance
1.	Unforeseen Conditions	\$10,000
2.	Materials Testing Lab	\$5,000
3.	Owner-Directed Changes	\$10,000
Total Amount For Allowances		\$25,000

5.3.1. Cash allowances are included in the price(s) set forth above, and have been computed in accordance with Paragraph 13.02.B of the General Conditions.

5.4. Bid Summary

5.4.1. Lump Sum Base Bid: \$_____

5.4.2. Cash Allowances: \$25,000

5.4.3. Total Bid (Sum of Above): \$_____

6. TIME OF COMPLETION

6.1. Bidder agrees the Work will be substantially complete and will be completed and ready for final payment in accordance with Paragraph 15.06 of the General Conditions on or before the dates, or within the number of calendar days, indicated in the Agreement.

6.2. Bidder accepts the provisions of the Agreement as to liquidated damages in the event of failure to complete the Work, and any specified Milestones, within the Contract Times.

7. ATTACHMENTS TO THIS BID

7.1. The following documents are submitted with and made a condition of this Bid:

7.1.1. Required Bid security in the form of Bid bond.

7.1.2. Bidder's Experience.

7.1.3. Bidder's Qualification.

7.1.4. List of Project References.

7.1.5. Evidence of authority to do business in the state of the Project; or a written covenant to obtain such license within the time for acceptance of Bids.

7.1.6. Contractor's License No.: _____.

7.1.7. Noncollusion Affidavit.

8. DEFINED TERMS

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

9. BID SUBMITTAL

9.1. This Bid submitted by:

If Bidder is:

An Individual

Name (typed or printed): _____

By (signature): _____

Doing business as: _____

A Partnership

Partnership Name: _____ (SEAL)

By: _____
(Signature of general partner – attach evidence of authority to sign)

Name (typed or printed): _____

A Corporation

Corporation Name: _____ (SEAL)

State of Incorporation: _____

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

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

Name (typed or printed): _____

Title: _____ (CORPORATE SEAL)

Attest: _____
(Signature of Corporate Secretary)

Date of Qualification to do business in Georgia is:
_____.

A Joint Venture

Joint Venturer Name: _____ (SEAL)

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

Name (typed or printed): _____

Title: _____

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

Bidder's Business Address: _____

Phone No.: _____ FAX No.: _____

E-mail: _____

SUBMITTED on _____, 20_____

Georgia Contractor's License No.: _____

Contractor's License Class (where applicable): _____

END OF SECTION

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

END OF SECTION

STATEMENT OF NONCOLLUSION

Each Bidder shall complete the following statement in accordance with OCGA 36-91-21(e):

STATE OF _____ }
 _____ } ss
 COUNTY OF _____ }

That (s)he is the agent authorized by the Bidder to submit the attached bid. Affiant further states that the Bidder has not been a party to any collusion among Bidders in restraint of freedom of competition by agreement to bid at a fixed price or to refrain from bidding; or with any State, County, or City official or employee as to quantity, quality, or price in the prospective Contract, or any other terms of said prospective Contract; or in any discussions between Bidders and any State, County, or City official concerning exchange of money or other thing of value for special consideration in the letting of a contract.

Affiant further warrants that no person or selling agency has been employed or retained to solicit or secure such contract upon an agreement or understanding for a commission, percentage, brokerage or contingent fee, except bona fide employees or bona fide established commercial or selling agencies maintained by the Contractor for the purpose of securing business.

 Name of Contractor

 Bidder (Affiant)

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

My commission expires: _____

 Notary Public

END OF SECTION

PART 2

CONTRACTING REQUIREMENTS

AGREEMENT

THIS AGREEMENT is by and between Fayette County
 _(Owner) and _____
 _____ (Contractor).

Owner and Contractor, in consideration of the mutual covenants set forth herein, agree as follows:

1. WORK

1.1. Contractor shall complete the Work as specified or indicated in the Contract Documents. The Work is generally described as follows: Installation of a new chlorine dioxide generation system and associated bulk chemical storage at the South Fayette Water Treatment Plant.

2. ENGINEER

2.1. The Project has been designed by Jacobs Engineering Group (Engineer), who is to act as Owner's representative, assume duties and responsibilities, and have the rights and authority assigned to Engineer in the Contract Documents in connection with the completion of the Work in accordance with the Contract Documents.

3. CONTRACT TIMES

3.1. Time of the Essence: Time limits for Substantial Completion and completion and readiness for final payment as stated in the Contract Documents are of the essence of the Contract.

3.2. Days to Achieve Substantial Completion and Final Payment:

3.2.1. The Work shall be substantially completed within 270 days from the date when the Contract Times commence to run as provided in Paragraph 4.01 of the General Conditions, and completed and ready for final payment in accordance with Paragraph 15.06 of the General Conditions within **300** days after the date when the Contract Times commence to run.

3.3. Liquidated Damages:

3.3.1. Contractor and Owner recognize that time is of the essence of this Agreement and that Owner will suffer financial loss if the Work is not completed within the times specified in Paragraph Contract Times above, plus any extensions thereof allowed in accordance with Article 11 of the General Conditions. The parties also recognize the delays, expense, and difficulties involved in proving in a legal or arbitration proceeding the actual loss suffered

by Owner if the Work is not completed on time. Accordingly, instead of requiring any such proof, Owner and Contractor agree that as liquidated damages for delay (but not as a penalty) Contractor shall pay Owner \$500 for each day that expires after the time specified herein for Substantial Completion until the Work is substantially complete.

3.3.2. After Substantial Completion, if Contractor neglects, refuses, or fails to complete remaining Work within the Contract Time or any proper extension thereof granted by Owner, Contractor shall pay Owner \$200 for each day that expires after the time specified herein for completion and readiness for final payment until the Work is completed and ready for final payment.

4. CONTRACT PRICE

4.1. Owner will pay Contractor for completion of the Work in accordance with the Contract Documents an amount in current funds equal to the sum of the amounts determined pursuant to the following:

4.1.1. Lump Sum: For Work other than Unit Price Work, a lump sum of \$_____.

4.1.1.1. Cash allowance(s) are included in the above lump sum price and have been computed in accordance with Paragraph 13.02 of the General Conditions.

5. PAYMENT PROCEDURES

5.1. Submittal and Processing of Payments: Contractor shall submit Applications for Payment in accordance with Article 15 of the General Conditions. Applications for Payment will be processed by Engineer as provided in the General Conditions.

5.2. Progress Payments and Retainage: Owner will make progress payments on account of the Contract Price on the basis of Contractor's Application for Payment on the date of each month as established in the preconstruction conference during performance of the Work as provided herein. All such payments will be measured by the Schedule of Values established as provided in Paragraph 2.05 of the General Conditions (and in the case of Unit Price Work based on the number of units completed) or, in the event there is no Schedule of Values, as provided in the General Requirements.

5.2.1. Prior to Substantial Completion, progress payments will be made in an amount equal to the percentage indicated below less a retainage of ten percent (10%) but, in each case, less the aggregate of payments previously made and less such amounts as Engineer may determine or Owner may withhold, including but not limited to liquidated damages, in accordance with Paragraph 15.01 of the General Conditions:

5.2.1.1. Ninety percent of Work completed (with the balance being retainage). If the Work has been 50 percent completed as determined by Engineer, and if the character and progress of the Work have been satisfactory to Owner and Engineer, Owner, on recommendation of Engineer, may determine that as long as the character and progress of the Work remain satisfactory to them, there will be no additional retainage; and

5.2.1.2. Ninety percent of cost of materials and equipment not incorporated in the Work (with the balance being retainage).

5.2.2. Upon Substantial Completion, Owner will pay an amount sufficient to increase total payments to Contractor to 100 percent of the Work completed, less such amounts as Engineer will determine in accordance with Paragraph 15.01.C.6 of the General Conditions and less 200 percent of Engineer's estimate of the value of Work to be completed or corrected as shown on the tentative list of items to be completed or corrected attached to the certificate of Substantial Completion.

5.3. Final Payment:

5.3.1. Upon final completion and acceptance of the Work in accordance with Paragraph 15.06 of the General Conditions, Owner will pay the remainder of the Contract Price as recommended by Engineer as provided in Paragraph 15.06.

6. INTEREST

6.1. Monies not paid when due as provided in Article 15 of the General Conditions shall bear interest at the rate of one-half percent per month.

7. CONTRACTOR'S REPRESENTATIONS

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

7.1.1. Contractor has examined and carefully studied the Contract Documents and the other related data identified in the Bidding Documents.

7.1.2. Contractor has visited the Site and become familiar with and is satisfied as to the general, local, and Site conditions that may affect cost, progress, and performance of the Work.

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

7.1.4. Contractor has carefully studied: (1) reports of explorations and tests of subsurface conditions at or contiguous to the Site and drawings of physical conditions relating to existing surface or subsurface structures at the Site (except Underground Facilities) if any, which have been identified in Paragraph 5.03 of the Supplementary Conditions as containing reliable “technical data”, and (2) reports and drawings of Hazardous Environmental Conditions, if any, at the Site which have been identified in Paragraph 5.06 of the Supplementary Conditions as containing reliable “technical data.”

7.1.5. Contractor has considered the information known to Contractor; information commonly known to contractors doing business in the locality of the Site; information and observations obtained from visits to the Site; the Contract Documents; and Site-related reports and drawings identified in the Contract Documents, with respect to the effect of such information, observations, and documents on 1) the cost, progress, and performance of the Work; 2) the means, methods, techniques, sequences, and procedures of construction to be employed by Contractor, including any specific means, methods, techniques, sequences, and procedures of construction expressly required by the Contract Documents; and 3) Contractor’s safety precautions and programs.

7.1.6. Based on the information and observations referred to above, Contractor does not consider that any further examinations, investigations, explorations, tests, studies, or data are necessary for the performance of the Work at the Contract Price, within the Contract Times, and in accordance with the other terms and conditions of the Contract Documents.

7.1.7. Contractor is aware of the general nature of work to be performed by Owner and others at the Site that relates to the Work as indicated in the Contract Documents.

7.1.8. Contractor has given Engineer written notice of conflicts, errors, ambiguities, or discrepancies that Contractor has discovered in the Contract Documents, and the written resolution thereof by Engineer is acceptable to Contractor.

7.1.9. The Contract Documents are generally sufficient to indicate and convey understanding of terms and conditions for performance and furnishing of the Work.

8. CONTRACT DOCUMENTS

8.1. Contents:

8.1.1. The Contract Documents that are attached to this Agreement (except as expressly noted otherwise) consist of the following:

8.1.1.1. This Agreement (pages 1 to 8, inclusive).

8.1.1.2. Performance bond (pages 1 to 4, inclusive).

8.1.1.3. Payment bond (pages 1 to 4, inclusive).

8.1.1.4. Conditions of the Contract (pages ____ to ____, inclusive).

8.1.1.5. General Conditions (pages 1 to 58, inclusive).

8.1.1.6. Supplementary Conditions (pages 1 to 10, inclusive).

8.1.1.7. Specifications as listed in the table of contents of the Project Manual.

8.1.1.8. Drawings consisting of 36 sheets with each sheet bearing the following general title: South Fayette Water Treatment Plant, Chlorine Dioxide Generation System.

8.1.1.9. Addenda (numbers ____ to ____, inclusive).

8.1.2. Exhibits to this Agreement (enumerated as follows):

8.1.2.1. Contractor's Bid (pages ____ to ____, inclusive).

8.1.3. The following which may be delivered or issued on or after the Effective Date of the Agreement and are not attached hereto:

8.1.3.1. Notice to Proceed (pages ____ to ____, inclusive).

8.1.3.2. Work Change Directives.

8.1.3.3. Change Order(s).

8.2. There are no Contract Documents other than those listed above in this Article.

8.3. The Contract Documents may only be amended, modified, or supplemented as provided in Paragraph 11.01 of the General Conditions.

9. MISCELLANEOUS

9.1. Terms used in this Agreement will have the meanings stated in the General Conditions and the Supplementary Conditions.

9.2. Successors and Assigns: Owner and Contractor each binds itself, its partners, successors, assigns, and legal representatives to the other party hereto, its partners, successors, assigns, and legal representatives in respect to all covenants, agreements, and obligations contained in the Contract Documents.

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

9.4. Assignment of Contract:

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

9.5. Contractor's Certifications:

9.5.1. Contractor certifies that it has not engaged in corrupt, fraudulent, collusive, or coercive practices in competing for or in executing the Contract. For the purposes of this paragraph:

9.5.1.1. "corrupt practice" means the offering, giving, receiving, or soliciting of anything of value likely to influence the action of a public official in the bidding process or in Contract execution;

9.5.1.2. "fraudulent practice" means an intentional misrepresentation of facts made (a) to influence the bidding process or the execution of the Contract to the detriment of Owner, (b) to establish Bid or Contract Price at artificial noncompetitive levels, or (c) to deprive Owner of the benefits of free and open competition;

9.5.1.3. “collusive practice” means a scheme or arrangement between two or more Bidders, with or without the knowledge of Owner, a purpose of which is to establish Bid prices at artificial, noncompetitive levels; and

9.5.1.4. “coercive practice” means harming or threatening to harm, directly or indirectly, persons or their property to influence their participation in the bidding process or affect the execution of the Contract.

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

This Agreement will be effective on _____, 2019 (which is the Effective Date of the Agreement).

OWNER: _____

CONTRACTOR: _____

By: _____

By: _____

Title: _____

Title: _____

[CORPORATE SEAL]

[CORPORATE SEAL]

Attest: _____

Attest: _____

Title: _____

Title: _____

Address for giving notices:

Address for giving notices:

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

License No. _____
(Where applicable)

Agent for service or process: _____

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

END OF SECTION

Conditions of the Contract

ADDITIONAL TERMS AND CONDITIONS

1. **Definitions:** The term “contractor” as used herein and elsewhere in these specifications shall be used synonymously with the term “successful bidder.” The term “county” shall mean Fayette County, Georgia.
2. **Bid is Offer to Contract:** Each bid constitutes an offer to become legally bound to a contract with the county, incorporating the invitation to bid and the bidder’s bid. The binding offer includes compliance with all terms, conditions, special conditions, specifications, and requirements stated in the invitation to bid, except to the extent that a bidder takes written exception to such provisions. All such terms, conditions, special conditions, specifications, and requirements will form the basis of the contract. The bidder should take care to answer all questions and provide all requested information, and to note any exceptions in the bid submission. Failure to observe any of the instructions or conditions in this invitation to bid may result in rejection of the bid.
3. **Binding Offer:** Each bid shall constitute a firm offer that is binding for sixty (60) days from the date of the bid opening, unless the bidder takes exception to this provision in writing.
4. **Bid Submission:** Submit your bid, along with any addenda issued by the county, in a sealed opaque envelope with the following information written on the outside of the envelope:
 - a. The bidder’s company name,
 - b. The bid number, which is **#1598-B**, and
 - c. The “reference” which identifies the bid, which is **“South Fayette Water Treatment Plant, Chlorine Dioxide Generation System”**.

Mail or deliver one (1) unbound original bid (paperclip or binder clip acceptable, no staples), signed in ink by a company official authorized to make a legal and binding offer, to:

Fayette County Georgia
Purchasing Department
140 Stonewall Avenue West, Suite 204
Fayetteville, GA 30214

Attention: Contracts Administrator

You may submit bids in person, by U.S. mail, or by a commercial carrier. Do not submit bids by facsimile, e-mail, or other electronic means. Once submitted, all bids become the property of Fayette County.

5. **Bid Preparation Costs:** The bidder shall bear all costs associated with preparing the bid.
6. **Late Bids:** Bids not received by the time and date of the scheduled bid opening will not be considered, unless the delay is a result of action or inaction by the county.
7. **Defects or Irregularities in Bids:** The county reserves the right to waive any defect or irregularity in any bid received. In case of an error in extension of prices or totals in the bid, the unit prices shall govern.

8. **Non-Collusion:** By responding to this invitation to bid, the bidder represents that the bid is not made in connection with any competing bidder, supplier, or service provider submitting a separate response to this invitation to bid, and is in all respects fair and without collusion or fraud.
9. **Bid Evaluation:** Award will be made to the lowest responsive, responsible bidder, taking into consideration payment terms, vendor qualifications and experience, quality, references, any exceptions listed, and/or other factors deemed relevant in making the award. The county may make such investigation as it deems necessary to determine the ability of the bidder to perform, and the bidder shall furnish to the county all information and data for this purpose as the county may request. The county reserves the right to reject any bid item, any bid, or all bids, and to re-advertise for bids.
10. **Discounts:** Cash discounts offered will be a consideration in awarding the bid, but only if they give the county at least 15 days from receipt of invoice to pay. For taking discounts, time will be computed from the date of acceptance at destination or the date a correct invoice is received, whichever is the later date. Payment is deemed made, for the purpose of earning the discount, on the date of the check. For payment of full invoice price, minimum terms of net 30 are preferred.
11. **Trade Secrets - Confidentiality:** If any person or entity submits a bid or proposal that contains trade secrets, an affidavit shall be included with the bid or proposal. The affidavit shall declare the specific included information which constitutes trade secrets. Any trade secrets must be either (1) placed in a separate envelope, clearly identified and marked as such, or (2) at a minimum, marked in the affidavit or an attached document explaining exactly where such information is, and otherwise marked, highlighted, or made plainly visible. See O.C.G.A. § 50-18-72 (A)(34).
12. **Trade Secrets – Internal Use:** In submitting a bid, the bidder agrees that the county may reveal any trade secret materials contained in the bid to all county staff and officials involved in the selection process, and to any outside consultant or other third parties who may assist in the selection process. The bidder agrees to hold harmless the county and each of its officers, employees, and agents from all costs, damages, and expenses incurred in connection with refusing to disclose any material which the bidder has designated as a trade secret.
13. **Ethics – Disclosure of Relationships:** Before a proposed contract in excess of \$10,000.00 is recommended for award to the Board of Commissioners or the County Administrator, or before the County renews, extends, or otherwise modifies a contract after it has been awarded, the contractor must disclose certain relationships with any County Commissioner or County Official, or their spouse, mother, father, grandparent, brother, sister, son or daughter related by blood, adoption, or marriage (including in-laws). A relationship that must be reported exists if any of these individuals is a director, officer, partner, or employee, or has a substantial financial interest in the business, as described in Fayette County Ordinance Chapter 2, Article IV, Division 3 (Code of Ethics).

If such relationship exists between your company and any individual mentioned above, relevant information must be presented in the form of a written letter to the Director of Purchasing. You must include the letter with any bid, proposal, or price quote you submit to the Purchasing Department.

In the event that a contractor fails to comply with this requirement, the County will take action as appropriate to the situation, which may include actions up to and including rejection of the bid or offer, cancellation of the contract in question, or debarment or suspension from award of a County contract for a period of up to three years.

14. **Contract Execution & Notice to Proceed:** After the Board of Commissioners makes an award, all required documents are received by the county, and the contract is fully executed with signature of both parties, the county will issue a written Notice to Proceed. The county shall not be liable for payment of any work done or any costs incurred by any bidder prior to the county issuing the Notice to Proceed.
15. **Unavailability of Funds:** This contract will terminate immediately and absolutely at such time as appropriated and otherwise unobligated funds are no longer available to satisfy the obligations of the county under the contract.
16. **Insurance:** The successful bidder shall procure and maintain the following insurance, to be in effect throughout the term of the contract, in at least the amounts and limits as follows:
 - a. **General Liability Insurance:** \$1,000,000 combined single limit per occurrence, including bodily and personal injury, destruction of property, and contractual liability.
 - b. **Automobile Liability Insurance:** \$1,000,000 combined single limit each occurrence, including bodily injury and property damage liability.
 - c. **Worker's Compensation & Employer's Liability Insurance:** Workers Compensation as required by Georgia statute.
 - d. **Builder's "All Risk" Insurance:** In the event the contractor is performing construction services under the contract, contractor shall procure and maintain "all-risk" builder's insurance, providing coverage for the work performed under the contract, and the materials, equipment or other items incorporated therein, while the same are located at the construction site, stored off-site, or at the place of manufacture. The policy limit shall be at least 100% of the value of the contract, including any additional costs which are normally insured under such policy.

Before a contract with the successful bidder is executed, the successful bidder shall provide Certificates of Insurance for all required coverage. The successful offeror can provide the Certificate of Insurance after award of the contract, but must be provided prior to execution of the contract document by both parties. The certificate shall list additional insured as follows:

Fayette County, Georgia
140 Stonewall Avenue West
Fayetteville, GA 30214

Jacobs Engineering Group
10 10th Street, NE
Suite 1400
Atlanta, GA 30309

17. **Bid Bond:** You must include a bid bond with your bid, equal to five percent (5%) of the total amount bid. Bid bonds shall be provided by a surety which appears on Georgia's list of approved sureties administered by the State Insurance Commissioner, or the U.S. Treasury's list of approved bond sureties (Circular 570).
18. **Performance and Payment Bonds:** Prior to execution of a contract, the successful bidder shall submit performance and payment bonds each equal to 100 percent of the contract value, provided by a surety which appears on Georgia's list of approved sureties administered by the State Insurance Commissioner, or the U.S. Treasury's list of approved bond sureties (Circular 570).
19. **Unauthorized Performance:** The County will not compensate the contractor for work performed unless the work is authorized under the contract, as initially executed or as amended.
20. **Assignment of Contract:** Assignment of any contract resulting from this invitation to bid will not be authorized, except with express written authorization from the County.
21. **Severability:** The invalidity of one or more of the phrases, sentences, clauses or sections contained in the contract shall not affect the validity of the remaining portion of the contract. If any provision of the contract is held to be unenforceable, then both parties shall be relieved of all obligations arising under such provision to the extent that the provision is unenforceable. In such case, the contract shall be deemed amended to the extent necessary to make it enforceable while preserving its intent.
22. **Delivery Failures:** If the contractor fails to deliver contracted goods or services within the time specified in the contract, or fails to replace rejected items in a timely manner, the county shall have authority to make open-market purchases of comparable goods or services. The county shall have the right to invoice the contractor for any excess expenses incurred, or deduct such amount from monies owed the contractor. Such purchases shall be deducted from contracted quantities.
23. **Substitution of Contracted Items:** The contractor shall be obligated to deliver products awarded in this contract in accordance with terms and conditions specified herein. If a contractor is unable to deliver the products under the contract, it shall be the contractor's responsibility to obtain prior approval of the ordering agency to deliver an acceptable substitute at the same price quoted in the contractor's original bid. In the event any contractor consistently needs to substitute or refuses to substitute products, the County reserves the right to terminate the contract or invoke the "Delivery Failures" clause stated herein.
24. **Inspection and Acceptance of Deliveries:** The county reserves the right to inspect all goods and products delivered. The county will decide whether to accept or reject items delivered. The inspection shall be conclusive except with respect to latent defects, fraud, or such gross mistakes as shall amount to fraud. Final inspection resulting in acceptance or rejection of the products will be made as soon as practicable, but failure to inspect shall not be construed as a waiver by the county to

claim reimbursement or damages for such products which are later found to be in non-conformance with specifications. Should public necessity demand it, the county reserves the right to use or consume articles delivered which are substandard in quality, subject to an adjustment in price to be determined by the Purchasing Director.

25. **Force Majeure:** Neither party shall be deemed to be in breach of the contract to the extent that performance of its obligations is delayed, restricted, or prevented by reason of any act of God, natural disaster, act of government, or any other act or condition beyond the reasonable control of the party in question.
26. **Governing Law:** This agreement shall be governed in accordance with the laws of the State of Georgia. The parties agree to submit to the jurisdiction in Georgia, and further agree that any cause of action arising under this agreement shall be required to be brought in the appropriate venue in Fayette County, Georgia.
27. **Building Permits:** Work performed for the County requiring building permits by licensed contractors will not have permit fees assessed, although any re-inspection fees for disapproved inspections will be the responsibility of the contractor prior to final inspections and the Certificate of Occupancy or Certificate of Completion being issued.

PERFORMANCE BOND FORM

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

CONTRACTOR
(Name and Address):

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

OWNER (Name and Address):

Fayette County
140 Stonewall Avenue West, Suite 204
Fayetteville, GA 30214

CONTRACT

Date:

Amount:

Description: South Fayette Water Treatment Plant Chlorine Dioxide Generation System

BOND

Bond Number:

Date (Not earlier than Contract Date):

Amount:

Modifications to this Bond Form:

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

CONTRACTOR AS PRINCIPAL**SURETY**

Company:

Signature: _____ (Seal)
Name and Title

Surety's Name and Corporate Seal

By: _____
Signature and Title

(Attach Power of Attorney)

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

Attest: _____
Signature and Title

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CONTRACTOR AS PRINCIPAL

SURETY

Company:

Signature: _____(Seal)
Name and Title

_____(Seal)
Surety's Name and Corporate Seal

By: _____
Signature and Title

(Attach Power of Attorney)

Attest: _____
Signature and Title

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

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

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

3.1. Owner has notified Contractor and Surety, at the addresses described in Paragraph 10 below, that Owner is considering declaring a Contractor Default and has requested and attempted to arrange a conference with Contractor and Surety to be held not later than 15 days after receipt of such notice to discuss methods of performing the Contract. If Owner, Contractor and Surety agree, Contractor shall be allowed a reasonable time to perform the Contract, but such an agreement shall not waive Owner's right, if any, subsequently to declare a Contractor Default; and

3.2. Owner has declared a Contractor Default and formally terminated Contractor's right to complete the Contract. Such Contractor Default shall not be declared earlier than 20 days after Contractor and Surety have received notice as provided in Paragraph 3.1; and

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

1. Surety in accordance with the terms of the Contract;
2. Another contractor selected pursuant to Paragraph 4.3 to perform the Contract.

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

- 4.1. Arrange for Contractor, with consent of Owner, to perform and complete the Contract; or
- 4.2. Undertake to perform and complete the Contract itself, through its agents or through independent contractors; or

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

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

1. After investigation, determine the amount for which it may be liable to Owner and, as soon as practicable after the amount is determined, tender payment therefor to Owner; or
2. Deny liability in whole or in part and notify Owner citing reasons therefor.

5. If Surety does not proceed as provided in Paragraph 4 with reasonable promptness, Surety shall be deemed to be in default on this Bond 15 days after receipt of an additional written notice from Owner to Surety demanding that Surety perform its obligations under this Bond, and Owner shall be entitled to enforce any remedy available to Owner. If Surety proceeds as provided in Paragraph 4.4, and Owner refuses the payment tendered or Surety has denied liability, in whole or in part, without further notice Owner shall be entitled to enforce any remedy available to Owner.

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

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

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

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

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

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

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

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

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

12. Definitions.

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

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

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

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

FOR INFORMATION ONLY – Name, Address and Telephone Surety Agency or Broker Owner's Representative (engineer or other party)

END OF SECTION

PAYMENT BOND FORM

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

CONTRACTOR
(Name and Address):

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

OWNER (Name and Address):

Fayette County
140 Stonewell Avenue West, Suite 204
Fayetteville, Georgia 30214

CONTRACT

Date:

Amount:

Description: South Fayette Water Treatment Plant Chlorine Dioxide Generation System

BOND

Bond Number:

Date (Not earlier than Contract Date):

Amount:

Modifications to this Bond Form:

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

CONTRACTOR AS PRINCIPAL**SURETY**

Company:

Signature: _____(Seal)
Name and Title

_____(Seal)
Surety's Name and Corporate Seal

By: _____
Signature and Title

(Attach Power of Attorney)

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

Attest: _____
Signature and Title

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CONTRACTOR AS PRINCIPAL

SURETY

Company:

Signature: _____(Seal)
Name and Title

_____(Seal)
Surety's Name and Corporate Seal

By: _____
Signature and Title

(Attach Power of Attorney)

Attest: _____
Signature and Title

1. Contractor and Surety, jointly and severally, bind themselves, their heirs, executors, administrators, successors, and assigns to Owner to pay for labor, materials, and equipment furnished by Claimants for use in the performance of the Contract, which is incorporated herein by reference.
2. With respect to Owner, this obligation shall be null and void if Contractor:
 - 2.1. Promptly makes payment, directly or indirectly, for all sums due Claimants, and
 - 2.2. Defends, indemnifies, and holds harmless Owner from all claims, demands, liens, or suits alleging non-payment by Contractor by any person or entity who furnished labor, materials, or equipment for use in the performance of the Contract, provided Owner has promptly notified Contractor and Surety (at the addresses described in Paragraph 12) of any claims, demands, liens, or suits and tendered defense of such claims, demands, liens, or suits to Contractor and Surety, and provided there is no Owner Default.
3. With respect to Claimants, this obligation shall be null and void if Contractor promptly makes payment, directly or indirectly, for all sums due.
4. Surety shall have no obligation to Claimants under this Bond until:
 - 4.1. Claimants who are employed by or have a direct contract with Contractor have given notice to Surety (at the addresses described in Paragraph 12) and sent a copy, or notice thereof, to Owner, stating that a claim is being made under this Bond and, with substantial accuracy, the amount of the claim.
 - 4.2. Claimants who do not have a direct contract with Contractor:
 1. Have furnished written notice to Contractor and sent a copy, or notice thereof, to Owner, within 90 days after having last performed labor or last furnished materials or equipment included in the claim stating, with substantial accuracy, the amount of the claim and the name of the party to whom the materials or equipment were furnished or supplied, or for whom the labor was done or performed; and
 2. Have either received a rejection in whole or in part from Contractor, or not received within 30 days of furnishing the above notice any communication from Contractor by which Contractor had indicated the claim will be paid directly or indirectly; and
 3. Not having been paid within the above 30 days, have sent a written notice to Surety and sent a copy, or notice thereof, to Owner, stating that a claim is being made under this Bond and enclosing a copy of the previous written notice furnished to Contractor.
5. If a notice by a Claimant required by Paragraph 4 is provided by Owner to Contractor or to Surety, that is sufficient compliance.
6. Reserved.
7. Surety's total obligation shall not exceed the amount of this Bond, and the amount of this Bond shall be credited for any payments made in good faith by Surety.
8. Amounts owed by Owner to Contractor under the Contract shall be used for the performance of the Contract and to satisfy claims, if any, under any performance bond. By Contractor furnishing and Owner accepting this Bond, they agree that all funds earned by Contractor in the performance of the Contract are dedicated to satisfy obligations of Contractor and Surety under this Bond, subject to Owner's priority to use the funds for the completion of the Work.
9. Surety shall not be liable to Owner, Claimants, or others for obligations of Contractor that are unrelated to the Contract. Owner shall not be liable for payment of any costs or expenses of any Claimant under this Bond, and shall have under this Bond no obligations to make payments to, give notices on behalf of, or otherwise have obligations to Claimants under this Bond.
10. Surety hereby waives notice of any change, including changes of time, to the Contract or to related Subcontracts, purchase orders and other obligations.

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

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

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

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

15. Definitions:

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

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

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

FOR INFORMATION ONLY – Name, Address and Telephone
Surety Agency or Broker:
Owner's Representative (engineer or other party):

END OF SECTION

EXCEPTIONS TO SPECIFICATIONS

ITB #1598-B: South Fayette Water Treatment Plant, Chlorine Dioxide Generation System

Please list below any exceptions or clarifications to the specifications of this bid. Explain any exceptions in full.

This image shows a single sheet of white paper with horizontal ruling lines. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

COMPANY NAME: _____

STANDARD GENERAL CONDITIONS OF THE CONSTRUCTION CONTRACT

Prepared by



Issued and Published Jointly by



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ARTICLE 1 – DEFINITIONS AND TERMINOLOGY

1.01 *Defined Terms*

A. Wherever used in the Bidding Requirements or Contract Documents, a term printed with initial capital letters, including the term's singular and plural forms, will have the meaning indicated in the definitions below. In addition to terms specifically defined, terms with initial capital letters in the Contract Documents include references to identified articles and paragraphs, and the titles of other documents or forms.

1. *Addenda*—Written or graphic instruments issued prior to the opening of Bids which clarify, correct, or change the Bidding Requirements or the proposed Contract Documents.
2. *Agreement*—The written instrument, executed by Owner and Contractor, that sets forth the Contract Price and Contract Times, identifies the parties and the Engineer, and designates the specific items that are Contract Documents.
3. *Application for Payment*—The form acceptable to Engineer which is to be used by Contractor during the course of the Work in requesting progress or final payments and which is to be accompanied by such supporting documentation as is required by the Contract Documents.
4. *Bid*—The offer of a Bidder submitted on the prescribed form setting forth the prices for the Work to be performed.
5. *Bidder*—An individual or entity that submits a Bid to Owner.
6. *Bidding Documents*—The Bidding Requirements, the proposed Contract Documents, and all Addenda.
7. *Bidding Requirements*—The advertisement or invitation to bid, Instructions to Bidders, Bid Bond or other Bid security, if any, the Bid Form, and the Bid with any attachments.
8. *Change Order*—A document which is signed by Contractor and Owner and authorizes an addition, deletion, or revision in the Work or an adjustment in the Contract Price or the Contract Times, or other revision to the Contract, issued

on or after the Effective Date of the Contract.

9. *Change Proposal*—A written request by Contractor, duly submitted in compliance with the procedural requirements set forth herein, seeking an adjustment in Contract Price or Contract Times, or both; contesting an initial decision by Engineer concerning the requirements of the Contract Documents or the acceptability of Work under the Contract Documents; challenging a set-off against payments due; or seeking other relief with respect to the terms of the Contract.
10. *Claim*—(a) A demand or assertion by Owner directly to Contractor, duly submitted in compliance with the procedural requirements set forth herein: seeking an adjustment of Contract Price or Contract Times, or both; contesting an initial decision by Engineer concerning the requirements of the Contract Documents or the acceptability of Work under the Contract Documents; contesting Engineer's decision regarding a Change Proposal; seeking resolution of a contractual issue that Engineer has declined to address; or seeking other relief with respect to the terms of the Contract; or (b) a demand or assertion by Contractor directly to Owner, duly submitted in compliance with the procedural requirements set forth herein, contesting Engineer's decision regarding a Change Proposal; or seeking resolution of a contractual issue that Engineer has declined to address. A demand for money or services by a third party is not a Claim.
11. *Constituent of Concern*—Asbestos, petroleum, radioactive materials, polychlorinated biphenyls (PCBs), hazardous waste, and any substance, product, waste, or other material of any nature whatsoever that is or becomes listed, regulated, or addressed pursuant to (a) the Comprehensive Environmental Response, Compensation and Liability Act, 42 U.S.C. §§9601 et seq. ("CERCLA"); (b) the Hazardous Materials Transportation Act, 49 U.S.C. §§5501 et seq.; (c) the Resource Conservation and Recovery Act, 42 U.S.C. §§6901 et seq. ("RCRA"); (d) the Toxic Substances Control Act, 15 U.S.C.

- §§2601 et seq.; (e) the Clean Water Act, 33 U.S.C. §§1251 et seq.; (f) the Clean Air Act, 42 U.S.C. §§7401 et seq.; or (g) any other federal, state, or local statute, law, rule, regulation, ordinance, resolution, code, order, or decree regulating, relating to, or imposing liability or standards of conduct concerning, any hazardous, toxic, or dangerous waste, substance, or material.
12. *Contract*—The entire and integrated written contract between the Owner and Contractor concerning the Work.
 13. *Contract Documents*—Those items so designated in the Agreement, and which together comprise the Contract.
 14. *Contract Price*—The money that Owner has agreed to pay Contractor for completion of the Work in accordance with the Contract Documents. .
 15. *Contract Times*—The number of days or the dates by which Contractor shall: (a) achieve Milestones, if any; (b) achieve Substantial Completion; and (c) complete the Work.
 16. *Contractor*—The individual or entity with which Owner has contracted for performance of the Work.
 17. *Cost of the Work*—See Paragraph 13.01 for definition.
 18. *Drawings*—The part of the Contract that graphically shows the scope, extent, and character of the Work to be performed by Contractor.
 19. *Effective Date of the Contract*—The date, indicated in the Agreement, on which the Contract becomes effective.
 20. *Engineer*—The individual or entity named as such in the Agreement.
 21. *Field Order*—A written order issued by Engineer which requires minor changes in the Work but does not change the Contract Price or the Contract Times.
 22. *Hazardous Environmental Condition*—The presence at the Site of Constituents of Concern in such quantities or circumstances that may present a danger to persons or property exposed thereto. The presence at the Site of materials that are necessary for the execution of the Work, or that are to be incorporated in the Work, and that are controlled and contained pursuant to industry practices, Laws and Regulations, and the requirements of the Contract, does not establish a Hazardous Environmental Condition.
 23. *Laws and Regulations; Laws or Regulations*—Any and all applicable laws, statutes, rules, regulations, ordinances, codes, and orders of any and all governmental bodies, agencies, authorities, and courts having jurisdiction.
 24. *Liens*—Charges, security interests, or encumbrances upon Contract-related funds, real property, or personal property.
 25. *Milestone*—A principal event in the performance of the Work that the Contract requires Contractor to achieve by an intermediate completion date or by a time prior to Substantial Completion of all the Work.
 26. *Notice of Award*—The written notice by Owner to a Bidder of Owner's acceptance of the Bid.
 27. *Notice to Proceed*—A written notice by Owner to Contractor fixing the date on which the Contract Times will commence to run and on which Contractor shall start to perform the Work.
 28. *Owner*—The individual or entity with which Contractor has contracted regarding the Work, and which has agreed to pay Contractor for the performance of the Work, pursuant to the terms of the Contract.
 29. *Progress Schedule*—A schedule, prepared and maintained by Contractor, describing the sequence and duration of the activities comprising the Contractor's plan to accomplish the Work within the Contract Times.
 30. *Project*—The total undertaking to be accomplished for Owner by engineers, contractors, and others, including planning, study, design, construction, testing, commissioning, and start-up, and of which the Work to be performed under the Contract Documents is a part.
 31. *Project Manual*—The written documents prepared for, or made available for, procuring and constructing

- the Work, including but not limited to the Bidding Documents or other construction procurement documents, geotechnical and existing conditions information, the Agreement, bond forms, General Conditions, Supplementary Conditions, and Specifications. The contents of the Project Manual may be bound in one or more volumes.
32. *Resident Project Representative*—The authorized representative of Engineer assigned to assist Engineer at the Site. As used herein, the term Resident Project Representative or “RPR” includes any assistants or field staff of Resident Project Representative.
 33. *Samples*—Physical examples of materials, equipment, or workmanship that are representative of some portion of the Work and that establish the standards by which such portion of the Work will be judged.
 34. *Schedule of Submittals*—A schedule, prepared and maintained by Contractor, of required submittals and the time requirements for Engineer’s review of the submittals and the performance of related construction activities.
 35. *Schedule of Values*—A schedule, prepared and maintained by Contractor, allocating portions of the Contract Price to various portions of the Work and used as the basis for reviewing Contractor’s Applications for Payment.
 36. *Shop Drawings*—All drawings, diagrams, illustrations, schedules, and other data or information that are specifically prepared or assembled by or for Contractor and submitted by Contractor to illustrate some portion of the Work. Shop Drawings, whether approved or not, are not Drawings and are not Contract Documents.
 37. *Site*—Lands or areas indicated in the Contract Documents as being furnished by Owner upon which the Work is to be performed, including rights-of-way and easements, and such other lands furnished by Owner which are designated for the use of Contractor.
 38. *Specifications*—The part of the Contract that consists of written requirements for materials, equipment, systems, standards, and workmanship as applied to the Work, and certain administrative requirements and procedural matters applicable to the Work.
 39. *Subcontractor*—An individual or entity having a direct contract with Contractor or with any other Subcontractor for the performance of a part of the Work.
 40. *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.
 41. *Successful Bidder*—The Bidder whose Bid the Owner accepts, and to which the Owner makes an award of contract, subject to stated conditions.
 42. *Supplementary Conditions*—The part of the Contract that amends or supplements these General Conditions.
 43. *Supplier*—A manufacturer, fabricator, supplier, distributor, materialman, or vendor having a direct contract with Contractor or with any Subcontractor to furnish materials or equipment to be incorporated in the Work by Contractor or a Subcontractor.
 44. *Technical Data*—Those items expressly identified as Technical Data in the Supplementary Conditions, with respect to either (a) subsurface conditions at the Site, or physical conditions relating to existing surface or subsurface structures at the Site (except Underground Facilities) or (b) Hazardous Environmental Conditions at the Site. If no such express identifications of Technical Data have been made with respect to conditions at the Site, then the data contained in boring logs, recorded measurements of subsurface water levels, laboratory test results, and other factual, objective information regarding conditions at the Site that are set forth in any geotechnical or environmental report prepared for the Project and made

available to Contractor are hereby defined as Technical Data with respect to conditions at the Site under Paragraphs 5.03, 5.04, and 5.06.

45. *Underground Facilities*—All underground pipelines, conduits, ducts, cables, wires, manholes, vaults, tanks, tunnels, or other such facilities or attachments, and any encasements containing such facilities, including but not limited to those that convey electricity, gases, steam, liquid petroleum products, telephone or other communications, fiber optic transmissions, cable television, water, wastewater, storm water, other liquids or chemicals, or traffic or other control systems.
46. *Unit Price Work*—Work to be paid for on the basis of unit prices.
47. *Work*—The entire construction or the various separately identifiable parts thereof required to be provided under the Contract Documents. Work includes and is the result of performing or providing all labor, services, and documentation necessary to produce such construction; furnishing, installing, and incorporating all materials and equipment into such construction; and may include related services such as testing, start-up, and commissioning, all as required by the Contract Documents.
48. *Work Change Directive*—A written directive to Contractor issued on or after the Effective Date of the Contract, signed by Owner and recommended by Engineer, ordering an addition, deletion, or revision in the Work.

1.02 Terminology

- A. The words and terms discussed in the following paragraphs are not defined but, when used in the Bidding Requirements or Contract Documents, have the indicated meaning.
- B. Intent of Certain Terms or Adjectives:
1. The Contract Documents include the terms “as allowed,” “as approved,” “as ordered,” “as directed” or terms of like effect or import to authorize an exercise of professional judgment by Engineer. In addition, the adjectives “reasonable,” “suitable,” “acceptable,” “proper,” “satisfactory,” or adjectives of like effect

or import are used to describe an action or determination of Engineer as to the Work. It is intended that such exercise of professional judgment, action, or determination will be solely to evaluate, in general, the Work for compliance with the information in the Contract Documents and with the design concept of the Project as a functioning whole as shown or indicated in the Contract Documents (unless there is a specific statement indicating otherwise). The use of any such term or adjective is not intended to and shall not be effective to assign to Engineer any duty or authority to supervise or direct the performance of the Work, or any duty or authority to undertake responsibility contrary to the provisions of Article 10 or any other provision of the Contract Documents.

C. Day:

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

D. Defective:

1. The word “defective,” when modifying the word “Work,” refers to Work that is unsatisfactory, faulty, or deficient in that it:
 - a. does not conform to the Contract Documents; or
 - b. does not meet the requirements of any applicable inspection, reference standard, test, or approval referred to in the Contract Documents; or
 - c. has been damaged prior to Engineer’s recommendation of final payment (unless responsibility for the protection thereof has been assumed by Owner at Substantial Completion in accordance with Paragraph 15.03 or 15.04).

E. Furnish, Install, Perform, Provide:

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

2. The word “install,” when used in connection with services, materials, or equipment, shall mean to put into use or place in final position said services, materials, or equipment complete and ready for intended use.
 3. The words “perform” or “provide,” when used in connection with services, materials, or equipment, shall mean to furnish and install said services, materials, or equipment complete and ready for intended use.
 4. If the Contract Documents establish an obligation of Contractor with respect to specific services, materials, or equipment, but do not expressly use any of the four words “furnish,” “install,” “perform,” or “provide,” then Contractor shall furnish and install said services, materials, or equipment complete and ready for intended use.
- F. Unless stated otherwise in the Contract Documents, words or phrases that have a well-known technical or construction industry or trade meaning are used in the Contract Documents in accordance with such recognized meaning.

ARTICLE 2 – PRELIMINARY MATTERS

2.01 *Delivery of Bonds and Evidence of Insurance*

- A. *Bonds:* When Contractor delivers the executed counterparts of the Agreement to Owner, Contractor shall also deliver to Owner such bonds as Contractor may be required to furnish.
- B. *Evidence of Contractor’s Insurance:* When Contractor delivers the executed counterparts of the Agreement to Owner, Contractor shall also deliver to Owner, with copies to each named insured and additional insured (as identified in the Supplementary Conditions or elsewhere in the Contract), the certificates and other evidence of insurance required to be provided by Contractor in accordance with Article 6.
- C. *Evidence of Owner’s Insurance:* After receipt of the executed counterparts of the Agreement and all required bonds and insurance documentation, Owner shall promptly deliver to Contractor, with copies to each named insured and additional insured (as identified in the Supplementary Conditions or otherwise), the certificates and other evidence of

insurance required to be provided by Owner under Article 6.

2.02 *Copies of Documents*

- A. Owner shall furnish to Contractor four printed copies of the Contract (including one fully executed counterpart of the Agreement), and one copy in electronic portable document format (PDF). Additional printed copies will be furnished upon request at the cost of reproduction.
- B. Owner shall maintain and safeguard at least one original printed record version of the Contract, including Drawings and Specifications signed and sealed by Engineer and other design professionals. Owner shall make such original printed record version of the Contract available to Contractor for review. Owner may delegate the responsibilities under this provision to Engineer.

2.03 *Before Starting Construction*

- A. *Preliminary Schedules:* Within 10 days after the Effective Date of the Contract (or as otherwise specifically required by the Contract Documents), Contractor shall submit to Engineer for timely review:
 1. a preliminary Progress Schedule indicating the times (numbers of days or dates) for starting and completing the various stages of the Work, including any Milestones specified in the Contract;
 2. a preliminary Schedule of Submittals; and
 3. a preliminary Schedule of Values for all of the Work which includes quantities and prices of items which when added together equal the Contract Price and subdivides the Work into component parts in sufficient detail to serve as the basis for progress payments during performance of the Work. Such prices will include an appropriate amount of overhead and profit applicable to each item of Work.

2.04 *Preconstruction Conference; Designation of Authorized Representatives*

- A. Before any Work at the Site is started, a conference attended by Owner, Contractor, Engineer, and others as appropriate will be held to establish a working understanding among the parties as to the Work and to discuss the schedules referred to in Paragraph

2.03.A, procedures for handling Shop Drawings, Samples, and other submittals, processing Applications for Payment, electronic or digital transmittals, and maintaining required records.

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

2.05 *Initial Acceptance of Schedules*

- A. At least 10 days before submission of the first Application for Payment a conference, attended by Contractor, Engineer, and others as appropriate, will be held to review for acceptability to Engineer as provided below the schedules submitted in accordance with Paragraph 2.03.A. Contractor shall have an additional 10 days to make corrections and adjustments and to complete and resubmit the schedules. No progress payment shall be made to Contractor until acceptable schedules are submitted to Engineer.
 - 1. The Progress Schedule will be acceptable to Engineer if it provides an orderly progression of the Work to completion within the Contract Times. Such acceptance will not impose on Engineer responsibility for the Progress Schedule, for sequencing, scheduling, or progress of the Work, nor interfere with or relieve Contractor from Contractor's full responsibility therefor.
 - 2. Contractor's Schedule of Submittals will be acceptable to Engineer if it provides a workable arrangement for reviewing and processing the required submittals.
 - 3. Contractor's Schedule of Values will be acceptable to Engineer as to form and substance if it provides a reasonable allocation of the Contract Price to the component parts of the Work.

2.06 *Electronic Transmittals*

- A. Except as otherwise stated elsewhere in the Contract, the Owner, Engineer, and Contractor may transmit, and shall accept, Project-related correspondence, text, data, documents, drawings, information, and graphics, including but not limited to Shop Drawings and other submittals, in electronic

media or digital format, either directly, or through access to a secure Project website.

- B. If the Contract does not establish protocols for electronic or digital transmittals, then Owner, Engineer, and Contractor shall jointly develop such protocols.
- C. When transmitting items in electronic media or digital format, the transmitting party makes no representations as to long term compatibility, usability, or readability of the items resulting from the recipient's use of software application packages, operating systems, or computer hardware differing from those used in the drafting or transmittal of the items, or from those established in applicable transmittal protocols.

ARTICLE 3 – DOCUMENTS: INTENT, REQUIREMENTS, REUSE

3.01 *Intent*

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

3.02 *Reference Standards*

- A. Standards Specifications, Codes, Laws and Regulations
 - 1. Reference in the Contract Documents to standard specifications, manuals, reference standards, or codes of any technical society, organization, or association, or to Laws or Regulations, whether such reference be specific or by implication, shall mean the standard specification, manual, reference

standard, code, or Laws or Regulations in effect at the time of opening of Bids (or on the Effective Date of the Contract if there were no Bids), except as may be otherwise specifically stated in the Contract Documents.

2. No provision of any such standard specification, manual, reference standard, or code, or any instruction of a Supplier, shall be effective to change the duties or responsibilities of Owner, Contractor, or Engineer, or any of their subcontractors, consultants, agents, or employees, from those set forth in the part of the Contract Documents prepared by or for Engineer. No such provision or instruction shall be effective to assign to Owner, Engineer, or any of their officers, directors, members, partners, employees, agents, consultants, or subcontractors, any duty or authority to supervise or direct the performance of the Work or any duty or authority to undertake responsibility inconsistent with the provisions of the part of the Contract Documents prepared by or for Engineer.

3.03 *Reporting and Resolving Discrepancies*

A. Reporting Discrepancies:

1. *Contractor's Verification of Figures and Field Measurements:* Before undertaking each part of the Work, Contractor shall carefully study the Contract Documents, and check and verify pertinent figures and dimensions therein, particularly with respect to applicable field measurements. Contractor shall promptly report in writing to Engineer any conflict, error, ambiguity, or discrepancy that Contractor discovers, or has actual knowledge of, and shall not proceed with any Work affected thereby until the conflict, error, ambiguity, or discrepancy is resolved, by a clarification or interpretation by Engineer, or by an amendment or supplement to the Contract Documents issued pursuant to Paragraph 11.01.
2. *Contractor's Review of Contract Documents:* If, before or during the performance of the Work, Contractor discovers any conflict, error, ambiguity, or discrepancy within the Contract Documents, or between the Contract

Documents and (a) any applicable Law or Regulation, (b) actual field conditions, (c) any standard specification, manual, reference standard, or code, or (d) any instruction of any Supplier, then Contractor shall promptly report it to Engineer in writing. Contractor shall not proceed with the Work affected thereby (except in an emergency as required by Paragraph 7.15) until the conflict, error, ambiguity, or discrepancy is resolved, by a clarification or interpretation by Engineer, or by an amendment or supplement to the Contract Documents issued pursuant to Paragraph 11.01.

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

B. Resolving Discrepancies:

1. Except as may be otherwise specifically stated in the Contract Documents, the provisions of the part of the Contract Documents prepared by or for Engineer shall take precedence in resolving any conflict, error, ambiguity, or discrepancy between such provisions of the Contract Documents and:
 - a. the provisions of any standard specification, manual, reference standard, or code, or the instruction of any Supplier (whether or not specifically incorporated by reference as a Contract Document); or
 - b. the provisions of any Laws or Regulations applicable to the performance of the Work (unless such an interpretation of the provisions of the Contract Documents would result in violation of such Law or Regulation).

3.04 *Requirements of the Contract Documents*

- #### A. During the performance of the Work and until final payment, Contractor and Owner shall submit to the Engineer all matters in question concerning the requirements of the Contract Documents (sometimes referred to as requests for information or interpretation—RFIs), or relating to the acceptability of the Work under

the Contract Documents, as soon as possible after such matters arise. Engineer will be the initial interpreter of the requirements of the Contract Documents, and judge of the acceptability of the Work thereunder.

- B. Engineer will, with reasonable promptness, render a written clarification, interpretation, or decision on the issue submitted, or initiate an amendment or supplement to the Contract Documents. Engineer's written clarification, interpretation, or decision will be final and binding on Contractor, unless it appeals by submitting a Change Proposal, and on Owner, unless it appeals by filing a Claim.
- C. If a submitted matter in question concerns terms and conditions of the Contract Documents that do not involve (1) the performance or acceptability of the Work under the Contract Documents, (2) the design (as set forth in the Drawings, Specifications, or otherwise), or (3) other engineering or technical matters, then Engineer will promptly give written notice to Owner and Contractor that Engineer is unable to provide a decision or interpretation. If Owner and Contractor are unable to agree on resolution of such a matter in question, either party may pursue resolution as provided in Article 12.

3.05 *Reuse of Documents*

- A. Contractor and its Subcontractors and Suppliers shall not:
 - 1. have or acquire any title to or ownership rights in any of the Drawings, Specifications, or other documents (or copies of any thereof) prepared by or bearing the seal of Engineer or its consultants, including electronic media editions, or reuse any such Drawings, Specifications, other documents, or copies thereof on extensions of the Project or any other project without written consent of Owner and Engineer and specific written verification or adaptation by Engineer; or
 - 2. have or acquire any title or ownership rights in any other Contract Documents, reuse any such Contract Documents for any purpose without Owner's express written consent, or violate any copyrights pertaining to such Contract Documents.
- B. The prohibitions of this Paragraph 3.05 will survive final payment, or termination of the Contract. Nothing herein shall preclude

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

ARTICLE 4 – COMMENCEMENT AND PROGRESS OF THE WORK

4.01 *Commencement of Contract Times; Notice to Proceed*

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

4.02 *Starting the Work*

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

4.03 *Reference Points*

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

4.04 *Progress Schedule*

- A. Contractor shall adhere to the Progress Schedule established in accordance with Paragraph 2.05 as it may be adjusted from time to time as provided below.
 - 1. Contractor shall submit to Engineer for acceptance (to the extent indicated in Paragraph 2.05) proposed adjustments in the Progress Schedule that will not result in changing the Contract Times.

2. Proposed adjustments in the Progress Schedule that will change the Contract Times shall be submitted in accordance with the requirements of Article 11.
- B. Contractor shall carry on the Work and adhere to the Progress Schedule during all disputes or disagreements with Owner. No Work shall be delayed or postponed pending resolution of any disputes or disagreements, or during any appeal process, except as permitted by Paragraph 16.04, or as Owner and Contractor may otherwise agree in writing.

4.05 *Delays in Contractor's Progress*

- A. If Owner, Engineer, or anyone for whom Owner is responsible, delays, disrupts, or interferes with the performance or progress of the Work, then Contractor shall be entitled to an equitable adjustment in the Contract Times and Contract Price. Contractor's entitlement to an adjustment of the Contract Times is conditioned on such adjustment being essential to Contractor's ability to complete the Work within the Contract Times.
- B. Contractor shall not be entitled to an adjustment in Contract Price or Contract Times for delay, disruption, or interference caused by or within the control of Contractor. Delay, disruption, and interference attributable to and within the control of a Subcontractor or Supplier shall be deemed to be within the control of Contractor.
- C. If Contractor's performance or progress is delayed, disrupted, or interfered with by unanticipated causes not the fault of and beyond the control of Owner, Contractor, and those for which they are responsible, then Contractor shall be entitled to an equitable adjustment in Contract Times. Contractor's entitlement to an adjustment of the Contract Times is conditioned on such adjustment being essential to Contractor's ability to complete the Work within the Contract Times. Such an adjustment shall be Contractor's sole and exclusive remedy for the delays, disruption, and interference described in this paragraph. Causes of delay, disruption, or interference that may give rise to an adjustment in Contract Times under this paragraph include but are not limited to the following:
 1. severe and unavoidable natural catastrophes such as fires, floods, epidemics, and earthquakes;
 2. abnormal weather conditions;
 3. acts or failures to act of utility owners (other than those performing other work at or adjacent to the Site by arrangement with the Owner, as contemplated in Article 8); and
 4. acts of war or terrorism.
- D. Delays, disruption, and interference to the performance or progress of the Work resulting from the existence of a differing subsurface or physical condition, an Underground Facility that was not shown or indicated by the Contract Documents, or not shown or indicated with reasonable accuracy, and those resulting from Hazardous Environmental Conditions, are governed by Article 5.
- E. Paragraph 8.03 governs delays, disruption, and interference to the performance or progress of the Work resulting from the performance of certain other work at or adjacent to the Site.
- F. Contractor shall not be entitled to an adjustment in Contract Price or Contract Times for any delay, disruption, or interference if such delay is concurrent with a delay, disruption, or interference caused by or within the control of Contractor.
- G. Contractor must submit any Change Proposal seeking an adjustment in Contract Price or Contract Times under this paragraph within 30 days of the commencement of the delaying, disrupting, or interfering event.

ARTICLE 5 – AVAILABILITY OF LANDS; SUBSURFACE AND PHYSICAL CONDITIONS; HAZARDOUS ENVIRONMENTAL CONDITIONS

5.01 *Availability of Lands*

- A. Owner shall furnish the Site. Owner shall notify Contractor of any encumbrances or restrictions not of general application but specifically related to use of the Site with which Contractor must comply in performing the Work.
- B. Upon reasonable written request, Owner shall furnish Contractor with a current statement of record legal title and legal description of the lands upon which permanent improvements are to be made and Owner's interest therein as necessary for giving notice of or filing a mechanic's or construction lien against such lands in accordance with applicable Laws and Regulations.

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

5.02 *Use of Site and Other Areas*

A. Limitation on Use of Site and Other Areas:

1. Contractor shall confine construction equipment, temporary construction facilities, the storage of materials and equipment, and the operations of workers to the Site, adjacent areas that Contractor has arranged to use through construction easements or otherwise, and other adjacent areas permitted by Laws and Regulations, and shall not unreasonably encumber the Site and such other adjacent areas with construction equipment or other materials or equipment. Contractor shall assume full responsibility for (a) damage to the Site; (b) damage to any such other adjacent areas used for Contractor's operations; (c) damage to any other adjacent land or areas; and (d) for injuries and losses sustained by the owners or occupants of any such land or areas; provided that such damage or injuries result from the performance of the Work or from other actions or conduct of the Contractor or those for which Contractor is responsible.
2. If a damage or injury claim is made by the owner or occupant of any such land or area because of the performance of the Work, or because of other actions or conduct of the Contractor or those for which Contractor is responsible, Contractor shall (a) take immediate corrective or remedial action as required by Paragraph 7.12, or otherwise; (b) promptly attempt to settle the claim as to all parties through negotiations with such owner or occupant, or otherwise resolve the claim by arbitration or other dispute resolution proceeding, or at law; and (c) to the fullest extent permitted by Laws and Regulations, indemnify and hold harmless Owner and Engineer, and the officers, directors, members, partners, employees, agents, consultants and subcontractors of each and any of them from and against any such claim, and against all costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all

court or arbitration or other dispute resolution costs) arising out of or relating to any claim or action, legal or equitable, brought by any such owner or occupant against Owner, Engineer, or any other party indemnified hereunder to the extent caused directly or indirectly, in whole or in part by, or based upon, Contractor's performance of the Work, or because of other actions or conduct of the Contractor or those for which Contractor is responsible.

- B. *Removal of Debris During Performance of the Work:* During the progress of the Work the Contractor shall keep the Site and other adjacent areas free from accumulations of waste materials, rubbish, and other debris. Removal and disposal of such waste materials, rubbish, and other debris shall conform to applicable Laws and Regulations.
- C. *Cleaning:* Prior to Substantial Completion of the Work Contractor shall clean the Site and the Work and make it ready for utilization by Owner. At the completion of the Work Contractor shall remove from the Site and adjacent areas all tools, appliances, construction equipment and machinery, and surplus materials and shall restore to original condition all property not designated for alteration by the Contract Documents.
- D. *Loading of Structures:* Contractor shall not load nor permit any part of any structure to be loaded in any manner that will endanger the structure, nor shall Contractor subject any part of the Work or adjacent structures or land to stresses or pressures that will endanger them.

5.03 *Subsurface and Physical Conditions*

- A. *Reports and Drawings:* The Supplementary Conditions identify:
 1. those reports known to Owner of explorations and tests of subsurface conditions at or adjacent to the Site;
 2. those drawings known to Owner of physical conditions relating to existing surface or subsurface structures at the Site (except Underground Facilities); and
 3. Technical Data contained in such reports and drawings.
- B. *Reliance by Contractor on Technical Data Authorized:* Contractor may rely upon the accuracy of the Technical Data expressly identified in the Supplementary Conditions

with respect to such reports and drawings, but such reports and drawings are not Contract Documents. If no such express identification has been made, then Contractor may rely upon the accuracy of the Technical Data (as defined in Article 1) contained in any geotechnical or environmental report prepared for the Project and made available to Contractor. Except for such reliance on Technical Data, Contractor may not rely upon or make any claim against Owner or Engineer, or any of their officers, directors, members, partners, employees, agents, consultants, or subcontractors, with respect to:

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

5.04 *Differing Subsurface or Physical Conditions*

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

1. is of such a nature as to establish that any Technical Data on which Contractor is entitled to rely as provided in Paragraph 5.03 is materially inaccurate; or
2. is of such a nature as to require a change in the Drawings or Specifications; or
3. differs materially from that shown or indicated in the Contract Documents; or
4. is of an unusual nature, and differs materially from conditions ordinarily encountered and generally recognized as inherent in work of the character provided for in the Contract Documents;

then Contractor shall, promptly after becoming aware thereof and before further disturbing the subsurface or physical conditions or performing any Work in connection therewith (except in an emergency as required by Paragraph 7.15), notify Owner

and Engineer in writing about such condition. Contractor shall not further disturb such condition or perform any Work in connection therewith (except with respect to an emergency) until receipt of a written statement permitting Contractor to do so.

B. *Engineer's Review:* After receipt of written notice as required by the preceding paragraph, Engineer will promptly review the subsurface or physical condition in question; determine the necessity of Owner's obtaining additional exploration or tests with respect to the condition; conclude whether the condition falls within any one or more of the differing site condition categories in Paragraph 5.04.A above; obtain any pertinent cost or schedule information from Contractor; prepare recommendations to Owner regarding the Contractor's resumption of Work in connection with the subsurface or physical condition in question and the need for any change in the Drawings or Specifications; and advise Owner in writing of Engineer's findings, conclusions, and recommendations.

C. *Owner's Statement to Contractor Regarding Site Condition:* After receipt of Engineer's written findings, conclusions, and recommendations, Owner shall issue a written statement to Contractor (with a copy to Engineer) regarding the subsurface or physical condition in question, addressing the resumption of Work in connection with such condition, indicating whether any change in the Drawings or Specifications will be made, and adopting or rejecting Engineer's written findings, conclusions, and recommendations, in whole or in part.

D. *Possible Price and Times Adjustments:*

1. Contractor shall be entitled to an equitable adjustment in Contract Price or Contract Times, or both, to the extent that the existence of a differing subsurface or physical condition, or any related delay, disruption, or interference, causes an increase or decrease in Contractor's cost of, or time required for, performance of the Work; subject, however, to the following:

- a. such condition must fall within any one or more of the categories described in Paragraph 5.04.A;
- b. with respect to Work that is paid for on a unit price basis, any adjustment in Contract Price will

be subject to the provisions of Paragraph 13.03; and,

- c. Contractor's entitlement to an adjustment of the Contract Times is conditioned on such adjustment being essential to Contractor's ability to complete the Work within the Contract Times.
2. Contractor shall not be entitled to any adjustment in the Contract Price or Contract Times with respect to a subsurface or physical condition if:
 - a. Contractor knew of the existence of such condition at the time Contractor made a commitment to Owner with respect to Contract Price and Contract Times by the submission of a Bid or becoming bound under a negotiated contract, or otherwise; or
 - b. the existence of such condition reasonably could have been discovered or revealed as a result of any examination, investigation, exploration, test, or study of the Site and contiguous areas expressly required by the Bidding Requirements or Contract Documents to be conducted by or for Contractor prior to Contractor's making such commitment; or
 - c. Contractor failed to give the written notice as required by Paragraph 5.04.A.
3. If Owner and Contractor agree regarding Contractor's entitlement to and the amount or extent of any adjustment in the Contract Price or Contract Times, or both, then any such adjustment shall be set forth in a Change Order.
4. Contractor may submit a Change Proposal regarding its entitlement to or the amount or extent of any adjustment in the Contract Price or Contract Times, or both, no later than 30 days after Owner's issuance of the Owner's written statement to Contractor regarding the subsurface or physical condition in question.

5.05 *Underground Facilities*

- A. *Contractor's Responsibilities:* The information and data shown or indicated in the Contract Documents with respect to existing

Underground Facilities at or adjacent to the Site is based on information and data furnished to Owner or Engineer by the owners of such Underground Facilities, including Owner, or by others. Unless it is otherwise expressly provided in the Supplementary Conditions:

1. Owner and Engineer do not warrant or guarantee the accuracy or completeness of any such information or data provided by others; and
 2. the cost of all of the following will be included in the Contract Price, and Contractor shall have full responsibility for:
 - a. reviewing and checking all information and data regarding existing Underground Facilities at the Site;
 - b. locating all Underground Facilities shown or indicated in the Contract Documents as being at the Site;
 - c. coordination of the Work with the owners (including Owner) of such Underground Facilities, during construction; and
 - d. the safety and protection of all existing Underground Facilities at the Site, and repairing any damage thereto resulting from the Work.
- B. *Notice by Contractor:* If Contractor believes that an Underground Facility that is uncovered or revealed at the Site was not shown or indicated in the Contract Documents, or was not shown or indicated with reasonable accuracy, then Contractor shall, promptly after becoming aware thereof and before further disturbing conditions affected thereby or performing any Work in connection therewith (except in an emergency as required by Paragraph 7.15), identify the owner of such Underground Facility and give written notice to that owner and to Owner and Engineer.
 - C. *Engineer's Review:* Engineer will promptly review the Underground Facility and conclude whether such Underground Facility was not shown or indicated in the Contract Documents, or was not shown or indicated with reasonable accuracy; obtain any pertinent cost or schedule information from Contractor; prepare recommendations to Owner regarding the Contractor's resumption of Work in connection with the Underground Facility in question; determine the extent, if any, to

which a change is required in the Drawings or Specifications to reflect and document the consequences of the existence or location of the Underground Facility; and advise Owner in writing of Engineer's findings, conclusions, and recommendations. During such time, Contractor shall be responsible for the safety and protection of such Underground Facility.

D. *Owner's Statement to Contractor Regarding Underground Facility:* After receipt of Engineer's written findings, conclusions, and recommendations, Owner shall issue a written statement to Contractor (with a copy to Engineer) regarding the Underground Facility in question, addressing the resumption of Work in connection with such Underground Facility, indicating whether any change in the Drawings or Specifications will be made, and adopting or rejecting Engineer's written findings, conclusions, and recommendations in whole or in part.

E. Possible Price and Times Adjustments:

1. Contractor shall be entitled to an equitable adjustment in the Contract Price or Contract Times, or both, to the extent that any existing Underground Facility at the Site that was not shown or indicated in the Contract Documents, or was not shown or indicated with reasonable accuracy, or any related delay, disruption, or interference, causes an increase or decrease in Contractor's cost of, or time required for, performance of the Work; subject, however, to the following:
 - a. Contractor did not know of and could not reasonably have been expected to be aware of or to have anticipated the existence or actual location of the Underground Facility in question;
 - b. With respect to Work that is paid for on a unit price basis, any adjustment in Contract Price will be subject to the provisions of Paragraph 13.03;
 - c. Contractor's entitlement to an adjustment of the Contract Times is conditioned on such adjustment being essential to Contractor's ability to complete the Work within the Contract Times; and
 - d. Contractor gave the notice required in Paragraph 5.05.B.

2. If Owner and Contractor agree regarding Contractor's entitlement to and the amount or extent of any adjustment in the Contract Price or Contract Times, or both, then any such adjustment shall be set forth in a Change Order.
3. Contractor may submit a Change Proposal regarding its entitlement to or the amount or extent of any adjustment in the Contract Price or Contract Times, or both, no later than 30 days after Owner's issuance of the Owner's written statement to Contractor regarding the Underground Facility in question.

5.06 *Hazardous Environmental Conditions at Site*

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

1. those reports and drawings known to Owner relating to Hazardous Environmental Conditions that have been identified at or adjacent to the Site; and
2. Technical Data contained in such reports and drawings.

B. *Reliance by Contractor on Technical Data Authorized:* Contractor may rely upon the accuracy of the Technical Data expressly identified in the Supplementary Conditions with respect to such reports and drawings, but such reports and drawings are not Contract Documents. If no such express identification has been made, then Contractor may rely on the accuracy of the Technical Data (as defined in Article 1) contained in any geotechnical or environmental report prepared for the Project and made available to Contractor. Except for such reliance on Technical Data, Contractor may not rely upon or make any claim against Owner or Engineer, or any of their officers, directors, members, partners, employees, agents, consultants, or subcontractors with respect to:

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

3. any Contractor interpretation of or conclusion drawn from any Technical Data or any such other data, interpretations, opinions or information.
- C. Contractor shall not be responsible for removing or remediating any Hazardous Environmental Condition encountered, uncovered, or revealed at the Site unless such removal or remediation is expressly identified in the Contract Documents to be within the scope of the Work.
- D. Contractor shall be responsible for controlling, containing, and duly removing all Constituents of Concern brought to the Site by Contractor, Subcontractors, Suppliers, or anyone else for whom Contractor is responsible, and for any associated costs; and for the costs of removing and remediating any Hazardous Environmental Condition created by the presence of any such Constituents of Concern.
- E. If Contractor encounters, uncovers, or reveals a Hazardous Environmental Condition whose removal or remediation is not expressly identified in the Contract Documents as being within the scope of the Work, or if Contractor or anyone for whom Contractor is responsible creates a Hazardous Environmental Condition, then Contractor shall immediately: (1) secure or otherwise isolate such condition; (2) stop all Work in connection with such condition and in any area affected thereby (except in an emergency as required by Paragraph 7.15); and (3) notify Owner and Engineer (and promptly thereafter confirm such notice in writing). Owner shall promptly consult with Engineer concerning the necessity for Owner to retain a qualified expert to evaluate such condition or take corrective action, if any. Promptly after consulting with Engineer, Owner shall take such actions as are necessary to permit Owner to timely obtain required permits and provide Contractor the written notice required by Paragraph 5.06.F. If Contractor or anyone for whom Contractor is responsible created the Hazardous Environmental Condition in question, then Owner may remove and remediate the Hazardous Environmental Condition, and impose a set-off against payments to account for the associated costs.
- F. Contractor shall not resume Work in connection with such Hazardous Environmental Condition or in any affected area until after Owner has obtained any required permits related thereto, and delivered written notice to Contractor either (1) specifying that such condition and any affected area is or has been rendered safe for the resumption of Work, or (2) specifying any special conditions under which such Work may be resumed safely.
- G. If Owner and Contractor cannot agree as to entitlement to or on the amount or extent, if any, of any adjustment in Contract Price or Contract Times, or both, as a result of such Work stoppage or such special conditions under which Work is agreed to be resumed by Contractor, then within 30 days of Owner's written notice regarding the resumption of Work, Contractor may submit a Change Proposal, or Owner may impose a set-off.
- H. If after receipt of such written notice Contractor does not agree to resume such Work based on a reasonable belief it is unsafe, or does not agree to resume such Work under such special conditions, then Owner may order the portion of the Work that is in the area affected by such condition to be deleted from the Work, following the contractual change procedures in Article 11. Owner may have such deleted portion of the Work performed by Owner's own forces or others in accordance with Article 8.
- I. To the fullest extent permitted by Laws and Regulations, Owner shall indemnify and hold harmless Contractor, Subcontractors, and Engineer, and the officers, directors, members, partners, employees, agents, consultants, and subcontractors of each and any of them from and against all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to a Hazardous Environmental Condition, provided that such Hazardous Environmental Condition (1) was not shown or indicated in the Drawings, Specifications, or other Contract Documents, identified as Technical Data entitled to limited reliance pursuant to Paragraph 5.06.B, or identified in the Contract Documents to be included within the scope of the Work, and (2) was not created by Contractor or by anyone for whom Contractor is responsible. Nothing in this Paragraph 5.06.H shall obligate Owner to indemnify any individual or entity from and against the consequences of that individual's or entity's own negligence.
- J. To the fullest extent permitted by Laws and Regulations, Contractor shall indemnify and

hold harmless Owner and Engineer, and the officers, directors, members, partners, employees, agents, consultants, and subcontractors of each and any of them from and against all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to the failure to control, contain, or remove a Constituent of Concern brought to the Site by Contractor or by anyone for whom Contractor is responsible, or to a Hazardous Environmental Condition created by Contractor or by anyone for whom Contractor is responsible. Nothing in this Paragraph 5.06.J shall obligate Contractor to indemnify any individual or entity from and against the consequences of that individual's or entity's own negligence.

- K. The provisions of Paragraphs 5.03, 5.04, and 5.05 do not apply to the presence of Constituents of Concern or to a Hazardous Environmental Condition uncovered or revealed at the Site.

ARTICLE 6 – BONDS AND INSURANCE

6.01 *Performance, Payment, and Other Bonds*

- A. Contractor shall furnish a performance bond and a payment bond, each in an amount at least equal to the Contract Price, as security for the faithful performance and payment of all of Contractor's obligations under the Contract. These bonds shall remain in effect until one year after the date when final payment becomes due or until completion of the correction period specified in Paragraph 15.08, whichever is later, except as provided otherwise by Laws or Regulations, the Supplementary Conditions, or other specific provisions of the Contract. Contractor shall also furnish such other bonds as are required by the Supplementary Conditions or other specific provisions of the Contract.
- B. All bonds shall be in the form prescribed by the Contract except as provided otherwise by Laws or Regulations, and shall be executed by such sureties as are named in "Companies Holding Certificates of Authority as Acceptable Sureties on Federal Bonds and as Acceptable Reinsuring Companies" as published in Circular 570 (as amended and supplemented) by the Financial Management Service, Surety Bond Branch, U.S. Department of the Treasury. A bond signed by

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

- C. Contractor shall obtain the required bonds from surety companies that are duly licensed or authorized in the jurisdiction in which the Project is located to issue bonds in the required amounts.
- D. If the surety on a bond furnished by Contractor is declared bankrupt or becomes insolvent, or its right to do business is terminated in any state or jurisdiction where any part of the Project is located, or the surety ceases to meet the requirements above, then Contractor shall promptly notify Owner and Engineer and shall, within 20 days after the event giving rise to such notification, provide another bond and surety, both of which shall comply with the bond and surety requirements above.
- E. If Contractor has failed to obtain a required bond, Owner may exclude the Contractor from the Site and exercise Owner's termination rights under Article 16.
- F. Upon request, Owner shall provide a copy of the payment bond to any Subcontractor, Supplier, or other person or entity claiming to have furnished labor or materials used in the performance of the Work.

6.02 *Insurance—General Provisions*

- A. Owner and Contractor shall obtain and maintain insurance as required in this Article and in the Supplementary Conditions.
- B. All insurance required by the Contract to be purchased and maintained by Owner or Contractor shall be obtained from insurance companies that are duly licensed or authorized, in the state or jurisdiction in which the Project is located, to issue insurance policies for the required limits and coverages. Unless a different standard is indicated in the Supplementary Conditions, all companies that provide insurance policies required under this Contract shall have an A.M. Best rating of A-VII or better.
- C. Contractor shall deliver to Owner, with copies to each named insured and additional insured (as identified in this Article, in the Supplementary Conditions, or elsewhere in the Contract), certificates of insurance establishing that Contractor has obtained and is maintaining the policies, coverages, and

endorsements required by the Contract. Upon request by Owner or any other insured, Contractor shall also furnish other evidence of such required insurance, including but not limited to copies of policies and endorsements, and documentation of applicable self-insured retentions and deductibles. Contractor may block out (redact) any confidential premium or pricing information contained in any policy or endorsement furnished under this provision.

- D. Owner shall deliver to Contractor, with copies to each named insured and additional insured (as identified in this Article, the Supplementary Conditions, or elsewhere in the Contract), certificates of insurance establishing that Owner has obtained and is maintaining the policies, coverages, and endorsements required of Owner by the Contract (if any). Upon request by Contractor or any other insured, Owner shall also provide other evidence of such required insurance (if any), including but not limited to copies of policies and endorsements, and documentation of applicable self-insured retentions and deductibles. Owner may block out (redact) any confidential premium or pricing information contained in any policy or endorsement furnished under this provision.
- E. Failure of Owner or Contractor to demand such certificates or other evidence of the other party's full compliance with these insurance requirements, or failure of Owner or Contractor to identify a deficiency in compliance from the evidence provided, shall not be construed as a waiver of the other party's obligation to obtain and maintain such insurance.
- F. If either party does not purchase or maintain all of the insurance required of such party by the Contract, such party shall notify the other party in writing of such failure to purchase prior to the start of the Work, or of such failure to maintain prior to any change in the required coverage.
- G. If Contractor has failed to obtain and maintain required insurance, Owner may exclude the Contractor from the Site, impose an appropriate set-off against payment, and exercise Owner's termination rights under Article 16.
- H. Without prejudice to any other right or remedy, if a party has failed to obtain required insurance, the other party may elect to obtain equivalent insurance to protect such other

party's interests at the expense of the party who was required to provide such coverage, and the Contract Price shall be adjusted accordingly.

- I. Owner does not represent that insurance coverage and limits established in this Contract necessarily will be adequate to protect Contractor or Contractor's interests.
- J. The insurance and insurance limits required herein shall not be deemed as a limitation on Contractor's liability under the indemnities granted to Owner and other individuals and entities in the Contract.

6.03 Contractor's Insurance

- A. *Workers' Compensation:* Contractor shall purchase and maintain workers' compensation and employer's liability insurance for:
 - 1. claims under workers' compensation, disability benefits, and other similar employee benefit acts.
 - 2. United States Longshoreman and Harbor Workers' Compensation Act and Jones Act coverage (if applicable).
 - 3. claims for damages because of bodily injury, occupational sickness or disease, or death of Contractor's employees (by stop-gap endorsement in monopolist worker's compensation states).
 - 4. Foreign voluntary worker compensation (if applicable).
- B. *Commercial General Liability—Claims Covered:* Contractor shall purchase and maintain commercial general liability insurance, covering all operations by or on behalf of Contractor, on an occurrence basis, against:
 - 1. claims for damages because of bodily injury, sickness or disease, or death of any person other than Contractor's employees.
 - 2. claims for damages insured by reasonably available personal injury liability coverage.
 - 3. claims for damages, other than to the Work itself, because of injury to or destruction of tangible property wherever located, including loss of use resulting therefrom.
- C. *Commercial General Liability—Form and Content:* Contractor's commercial liability policy shall be written on a 1996 (or later) ISO

commercial general liability form (occurrence form) and include the following coverages and endorsements:

1. Products and completed operations coverage:
 - a. Such insurance shall be maintained for three years after final payment.
 - b. Contractor shall furnish Owner and each other additional insured (as identified in the Supplementary Conditions or elsewhere in the Contract) evidence of continuation of such insurance at final payment and three years thereafter.
 2. Blanket contractual liability coverage, to the extent permitted by law, including but not limited to coverage of Contractor's contractual indemnity obligations in Paragraph 7.18.
 3. Broad form property damage coverage.
 4. Severability of interest.
 5. Underground, explosion, and collapse coverage.
 6. Personal injury coverage.
 7. Additional insured endorsements that include both ongoing operations and products and completed operations coverage through ISO Endorsements CG 20 10 10 01 and CG 20 37 10 01 (together); or CG 20 10 07 04 and CG 20 37 07 04 (together); or their equivalent.
 8. For design professional additional insureds, ISO Endorsement CG 20 32 07 04, "Additional Insured—Engineers, Architects or Surveyors Not Engaged by the Named Insured" or its equivalent.
- D. *Automobile liability:* Contractor shall purchase and maintain automobile liability insurance against claims for damages because of bodily injury or death of any person or property damage arising out of the ownership, maintenance, or use of any motor vehicle. The automobile liability policy shall be written on an occurrence basis.
- E. *Umbrella or excess liability:* Contractor shall purchase and maintain umbrella or excess liability insurance written over the underlying employer's liability, commercial general liability, and automobile liability insurance described in the paragraphs above. Subject to industry-standard exclusions, the coverage
- afforded shall follow form as to each and every one of the underlying policies.
- F. *Contractor's pollution liability insurance:* Contractor shall purchase and maintain a policy covering third-party injury and property damage claims, including clean-up costs, as a result of pollution conditions arising from Contractor's operations and completed operations. This insurance shall be maintained for no less than three years after final completion.
- G. *Additional insureds:* The Contractor's commercial general liability, automobile liability, umbrella or excess, and pollution liability policies shall include and list as additional insureds Owner and Engineer, and any individuals or entities identified in the Supplementary Conditions; include coverage for the respective officers, directors, members, partners, employees, agents, consultants, and subcontractors of each and any of all such additional insureds; and the insurance afforded to these additional insureds shall provide primary coverage for all claims covered thereby (including as applicable those arising from both ongoing and completed operations) on a non-contributory basis. Contractor shall obtain all necessary endorsements to support these requirements.
- H. *Contractor's professional liability insurance:* If Contractor will provide or furnish professional services under this Contract, through a delegation of professional design services or otherwise, then Contractor shall be responsible for purchasing and maintaining applicable professional liability insurance. This insurance shall provide protection against claims arising out of performance of professional design or related services, and caused by a negligent error, omission, or act for which the insured party is legally liable. It shall be maintained throughout the duration of the Contract and for a minimum of two years after Substantial Completion. If such professional design services are performed by a Subcontractor, and not by Contractor itself, then the requirements of this paragraph may be satisfied through the purchasing and maintenance of such insurance by such Subcontractor.
- I. *General provisions:* The policies of insurance required by this Paragraph 6.03 shall:
1. include at least the specific coverages provided in this Article.

2. be written for not less than the limits of liability provided in this Article and in the Supplementary Conditions, or required by Laws or Regulations, whichever is greater.
3. contain a provision or endorsement that the coverage afforded will not be canceled, materially changed, or renewal refused until at least 10 days prior written notice has been given to Contractor. Within three days of receipt of any such written notice, Contractor shall provide a copy of the notice to Owner, Engineer, and each other insured under the policy.
4. remain in effect at least until final payment (and longer if expressly required in this Article) and at all times thereafter when Contractor may be correcting, removing, or replacing defective Work as a warranty or correction obligation, or otherwise, or returning to the Site to conduct other tasks arising from the Contract Documents.
5. be appropriate for the Work being performed and provide protection from claims that may arise out of or result from Contractor's performance of the Work and Contractor's other obligations under the Contract Documents, whether it is to be performed by Contractor, any Subcontractor or Supplier, or by anyone directly or indirectly employed by any of them to perform any of the Work, or by anyone for whose acts any of them may be liable.

J. The coverage requirements for specific policies of insurance must be met by such policies, and not by reference to excess or umbrella insurance provided in other policies.

6.04 *Owner's Liability Insurance*

- A. In addition to the insurance required to be provided by Contractor under Paragraph 6.03, Owner, at Owner's option, may purchase and maintain at Owner's expense Owner's own liability insurance as will protect Owner against claims which may arise from operations under the Contract Documents.
- B. Owner's liability policies, if any, operate separately and independently from policies required to be provided by Contractor, and Contractor cannot rely upon Owner's liability

policies for any of Contractor's obligations to the Owner, Engineer, or third parties.

6.05 *Property Insurance*

A. *Builder's Risk:* Unless otherwise provided in the Supplementary Conditions, Contractor shall purchase and maintain builder's risk insurance upon the Work on a completed value basis, in the amount of the full insurable replacement cost thereof (subject to such deductible amounts as may be provided in the Supplementary Conditions or required by Laws and Regulations). This insurance shall:

1. include the Owner and Contractor as named insureds, and all Subcontractors, and any individuals or entities required by the Supplementary Conditions to be insured under such builder's risk policy, as insureds or named insureds. For purposes of the remainder of this Paragraph 6.05, Paragraphs 6.06 and 6.07, and any corresponding Supplementary Conditions, the parties required to be insured shall collectively be referred to as "insureds."
2. be written on a builder's risk "all risk" policy form that shall at least include insurance for physical loss or damage to the Work, temporary buildings, falsework, and materials and equipment in transit, and shall insure against at least the following perils or causes of loss: fire; lightning; windstorm; riot; civil commotion; terrorism; vehicle impact; aircraft; smoke; theft; vandalism and malicious mischief; mechanical breakdown, boiler explosion, and artificially generated electric current; earthquake; volcanic activity, and other earth movement; flood; collapse; explosion; debris removal; demolition occasioned by enforcement of Laws and Regulations; water damage (other than that caused by flood); and such other perils or causes of loss as may be specifically required by the Supplementary Conditions. If insurance against mechanical breakdown, boiler explosion, and artificially generated electric current; earthquake; volcanic activity, and other earth movement; or flood, are not commercially available under builder's risk policies, by endorsement or otherwise, such insurance may be provided through other insurance policies acceptable to Owner and Contractor.

3. cover, as insured property, at least the following: (a) the Work and all materials, supplies, machinery, apparatus, equipment, fixtures, and other property of a similar nature that are to be incorporated into or used in the preparation, fabrication, construction, erection, or completion of the Work, including Owner-furnished or assigned property; (b) spare parts inventory required within the scope of the Contract; and (c) temporary works which are not intended to form part of the permanent constructed Work but which are intended to provide working access to the Site, or to the Work under construction, or which are intended to provide temporary support for the Work under construction, including scaffolding, form work, fences, shoring, falsework, and temporary structures.
4. cover expenses incurred in the repair or replacement of any insured property (including but not limited to fees and charges of engineers and architects).
5. extend to cover damage or loss to insured property while in temporary storage at the Site or in a storage location outside the Site (but not including property stored at the premises of a manufacturer or Supplier).
6. extend to cover damage or loss to insured property while in transit.
7. allow for partial occupation or use of the Work by Owner, such that those portions of the Work that are not yet occupied or used by Owner shall remain covered by the builder's risk insurance.
8. allow for the waiver of the insurer's subrogation rights, as set forth below.
9. provide primary coverage for all losses and damages caused by the perils or causes of loss covered.
10. not include a co-insurance clause.
11. include an exception for ensuing losses from physical damage or loss with respect to any defective workmanship, design, or materials exclusions.
12. include performance/hot testing and start-up.
13. be maintained in effect, subject to the provisions herein regarding Substantial

Completion and partial occupancy or use of the Work by Owner, until the Work is complete.

- B. *Notice of Cancellation or Change:* All the policies of insurance (and the certificates or other evidence thereof) required to be purchased and maintained in accordance with this Paragraph 6.05 will contain a provision or endorsement that the coverage afforded will not be canceled or materially changed or renewal refused until at least 10 days prior written notice has been given to the purchasing policyholder. Within three days of receipt of any such written notice, the purchasing policyholder shall provide a copy of the notice to each other insured.
- C. *Deductibles:* The purchaser of any required builder's risk or property insurance shall pay for costs not covered because of the application of a policy deductible.
- D. *Partial Occupancy or Use by Owner:* If Owner will occupy or use a portion or portions of the Work prior to Substantial Completion of all the Work as provided in Paragraph 15.04, then Owner (directly, if it is the purchaser of the builder's risk policy, or through Contractor) will provide notice of such occupancy or use to the builder's risk insurer. The builder's risk insurance shall not be canceled or permitted to lapse on account of any such partial use or occupancy; rather, those portions of the Work that are occupied or used by Owner may come off the builder's risk policy, while those portions of the Work not yet occupied or used by Owner shall remain covered by the builder's risk insurance.
- E. *Additional Insurance:* If Contractor elects to obtain other special insurance to be included in or supplement the builder's risk or property insurance policies provided under this Paragraph 6.05, it may do so at Contractor's expense.
- F. *Insurance of Other Property:* If the express insurance provisions of the Contract do not require or address the insurance of a property item or interest, such as tools, construction equipment, or other personal property owned by Contractor, a Subcontractor, or an employee of Contractor or a Subcontractor, then the entity or individual owning such property item will be responsible for deciding whether to insure it, and if so in what amount.

6.06 *Waiver of Rights*

- A. All policies purchased in accordance with Paragraph 6.05, expressly including the builder's risk policy, shall contain provisions to the effect that in the event of payment of any loss or damage the insurers will have no rights of recovery against any insureds thereunder, or against Engineer or its consultants, or their officers, directors, members, partners, employees, agents, consultants, or subcontractors. Owner and Contractor waive all rights against each other and the respective officers, directors, members, partners, employees, agents, consultants, and subcontractors of each and any of them, for all losses and damages caused by, arising out of, or resulting from any of the perils or causes of loss covered by such policies and any other property insurance applicable to the Work; and, in addition, waive all such rights against Engineer, its consultants, all Subcontractors, all individuals or entities identified in the Supplementary Conditions as insureds, and the officers, directors, members, partners, employees, agents, consultants, and subcontractors of each and any of them, under such policies for losses and damages so caused. None of the above waivers shall extend to the rights that any party making such waiver may have to the proceeds of insurance held by Owner or Contractor as trustee or fiduciary, or otherwise payable under any policy so issued.
- B. Owner waives all rights against Contractor, Subcontractors, and Engineer, and the officers, directors, members, partners, employees, agents, consultants and subcontractors of each and any of them, for:
 - 1. loss due to business interruption, loss of use, or other consequential loss extending beyond direct physical loss or damage to Owner's property or the Work caused by, arising out of, or resulting from fire or other perils whether or not insured by Owner; and
 - 2. loss or damage to the completed Project or part thereof caused by, arising out of, or resulting from fire or other insured peril or cause of loss covered by any property insurance maintained on the completed Project or part thereof by Owner during partial occupancy or use pursuant to Paragraph 15.04, after Substantial Completion pursuant to Paragraph 15.03, or after final payment pursuant to Paragraph 15.06.
- C. Any insurance policy maintained by Owner covering any loss, damage or consequential loss referred to in Paragraph 6.06.B shall contain provisions to the effect that in the event of payment of any such loss, damage, or consequential loss, the insurers will have no rights of recovery against Contractor, Subcontractors, or Engineer, or the officers, directors, members, partners, employees, agents, consultants, or subcontractors of each and any of them.
- D. Contractor shall be responsible for assuring that the agreement under which a Subcontractor performs a portion of the Work contains provisions whereby the Subcontractor waives all rights against Owner, Contractor, all individuals or entities identified in the Supplementary Conditions as insureds, the Engineer and its consultants, and the officers, directors, members, partners, employees, agents, consultants, and subcontractors of each and any of them, for all losses and damages caused by, arising out of, relating to, or resulting from any of the perils or causes of loss covered by builder's risk insurance and any other property insurance applicable to the Work.

6.07 *Receipt and Application of Property Insurance Proceeds*

- A. Any insured loss under the builder's risk and other policies of insurance required by Paragraph 6.05 will be adjusted and settled with the named insured that purchased the policy. Such named insured shall act as fiduciary for the other insureds, and give notice to such other insureds that adjustment and settlement of a claim is in progress. Any other insured may state its position regarding a claim for insured loss in writing within 15 days after notice of such claim.
- B. Proceeds for such insured losses may be made payable by the insurer either jointly to multiple insureds, or to the named insured that purchased the policy in its own right and as fiduciary for other insureds, subject to the requirements of any applicable mortgage clause. A named insured receiving insurance proceeds under the builder's risk and other policies of insurance required by Paragraph 6.05 shall distribute such proceeds in accordance with such agreement as the parties in interest may reach, or as otherwise required under the dispute resolution provisions of this Contract or applicable Laws and Regulations.

- C. If no other special agreement is reached, the damaged Work shall be repaired or replaced, the money so received applied on account thereof, and the Work and the cost thereof covered by Change Order, if needed.

ARTICLE 7 – CONTRACTOR’S RESPONSIBILITIES

7.01 *Supervision and Superintendence*

- A. Contractor shall supervise, inspect, and direct the Work competently and efficiently, devoting such attention thereto and applying such skills and expertise as may be necessary to perform the Work in accordance with the Contract Documents. Contractor shall be solely responsible for the means, methods, techniques, sequences, and procedures of construction.
- B. At all times during the progress of the Work, Contractor shall assign a competent resident superintendent who shall not be replaced without written notice to Owner and Engineer except under extraordinary circumstances.

7.02 *Labor; Working Hours*

- A. Contractor shall provide competent, suitably qualified personnel to survey and lay out the Work and perform construction as required by the Contract Documents. Contractor shall at all times maintain good discipline and order at the Site.
- B. Except as otherwise required for the safety or protection of persons or the Work or property at the Site or adjacent thereto, and except as otherwise stated in the Contract Documents, all Work at the Site shall be performed during regular working hours, Monday through Friday. Contractor will not perform Work on a Saturday, Sunday, or any legal holiday. Contractor may perform Work outside regular working hours or on Saturdays, Sundays, or legal holidays only with Owner’s written consent, which will not be unreasonably withheld.

7.03 *Services, Materials, and Equipment*

- A. Unless otherwise specified in the Contract Documents, Contractor shall provide and assume full responsibility for all services, materials, equipment, labor, transportation, construction equipment and machinery, tools, appliances, fuel, power, light, heat, telephone, water, sanitary facilities, temporary facilities, and all other facilities and incidentals necessary for the performance, testing, start up, and completion of the Work, whether or

not such items are specifically called for in the Contract Documents.

- B. All materials and equipment incorporated into the Work shall be of good quality and new, except as otherwise provided in the Contract Documents. All special warranties and guarantees required by the Specifications shall expressly run to the benefit of Owner. If required by Engineer, Contractor shall furnish satisfactory evidence (including reports of required tests) as to the source, kind, and quality of materials and equipment.
- C. All materials and equipment shall be stored, applied, installed, connected, erected, protected, used, cleaned, and conditioned in accordance with instructions of the applicable Supplier, except as otherwise may be provided in the Contract Documents.

7.04 *“Or Equals”*

- A. Whenever an item of material or equipment is specified or described in the Contract Documents by using the name of a proprietary item or the name of a particular Supplier, the Contract Price has been based upon Contractor furnishing such item as specified. The specification or description of such an item is intended to establish the type, function, appearance, and quality required. Unless the specification or description contains or is followed by words reading that no like, equivalent, or “or equal” item is permitted, Contractor may request that Engineer authorize the use of other items of material or equipment, or items from other proposed suppliers under the circumstances described below.
 - 1. If Engineer in its sole discretion determines that an item of material or equipment proposed by Contractor is functionally equal to that named and sufficiently similar so that no change in related Work will be required, Engineer shall deem it an “or equal” item. For the purposes of this paragraph, a proposed item of material or equipment will be considered functionally equal to an item so named if:
 - a. in the exercise of reasonable judgment Engineer determines that:
 - 1) it is at least equal in materials of construction, quality, durability, appearance,

- strength, and design characteristics;
- 2) it will reliably perform at least equally well the function and achieve the results imposed by the design concept of the completed Project as a functioning whole;
- 3) it has a proven record of performance and availability of responsive service; and
- 4) it is not objectionable to Owner.
- b. Contractor certifies that, if approved and incorporated into the Work:
 - 1) there will be no increase in cost to the Owner or increase in Contract Times; and
 - 2) it will conform substantially to the detailed requirements of the item named in the Contract Documents.
- B. *Contractor's Expense:* Contractor shall provide all data in support of any proposed "or equal" item at Contractor's expense.
- C. *Engineer's Evaluation and Determination:* Engineer will be allowed a reasonable time to evaluate each "or-equal" request. Engineer may require Contractor to furnish additional data about the proposed "or-equal" item. Engineer will be the sole judge of acceptability. No "or-equal" item will be ordered, furnished, installed, or utilized until Engineer's review is complete and Engineer determines that the proposed item is an "or-equal", which will be evidenced by an approved Shop Drawing or other written communication. Engineer will advise Contractor in writing of any negative determination.
- D. *Effect of Engineer's Determination:* Neither approval nor denial of an "or-equal" request shall result in any change in Contract Price. The Engineer's denial of an "or-equal" request shall be final and binding, and may not be reversed through an appeal under any provision of the Contract Documents.
- E. *Treatment as a Substitution Request:* If Engineer determines that an item of material or equipment proposed by Contractor does not qualify as an "or-equal" item, Contractor may

request that Engineer considered the proposed item as a substitute pursuant to Paragraph 7.05.

7.05 *Substitutes*

- A. Unless the specification or description of an item of material or equipment required to be furnished under the Contract Documents contains or is followed by words reading that no substitution is permitted, Contractor may request that Engineer authorize the use of other items of material or equipment under the circumstances described below. To the extent possible such requests shall be made before commencement of related construction at the Site.
 - 1. Contractor shall submit sufficient information as provided below to allow Engineer to determine if the item of material or equipment proposed is functionally equivalent to that named and an acceptable substitute therefor. Engineer will not accept requests for review of proposed substitute items of material or equipment from anyone other than Contractor.
 - 2. The requirements for review by Engineer will be as set forth in Paragraph 7.05.B, as supplemented by the Specifications, and as Engineer may decide is appropriate under the circumstances.
 - 3. Contractor shall make written application to Engineer for review of a proposed substitute item of material or equipment that Contractor seeks to furnish or use. The application:
 - a. shall certify that the proposed substitute item will:
 - 1) perform adequately the functions and achieve the results called for by the general design,
 - 2) be similar in substance to that specified, and
 - 3) be suited to the same use as that specified.
 - b. will state:
 - 1) the extent, if any, to which the use of the proposed substitute item will necessitate a change in Contract Times,

- 2) whether use of the proposed substitute item in the Work will require a change in any of the Contract Documents (or in the provisions of any other direct contract with Owner for other work on the Project) to adapt the design to the proposed substitute item, and
 - 3) whether incorporation or use of the proposed substitute item in connection with the Work is subject to payment of any license fee or royalty.
- c. will identify:
 - 1) all variations of the proposed substitute item from that specified, and
 - 2) available engineering, sales, maintenance, repair, and replacement services.
 - d. shall contain an itemized estimate of all costs or credits that will result directly or indirectly from use of such substitute item, including but not limited to changes in Contract Price, shared savings, costs of redesign, and claims of other contractors affected by any resulting change.
- B. *Engineer's Evaluation and Determination:* Engineer will be allowed a reasonable time to evaluate each substitute request, and to obtain comments and direction from Owner. Engineer may require Contractor to furnish additional data about the proposed substitute item. Engineer will be the sole judge of acceptability. No substitute will be ordered, furnished, installed, or utilized until Engineer's review is complete and Engineer determines that the proposed item is an acceptable substitute. Engineer's determination will be evidenced by a Field Order or a proposed Change Order accounting for the substitution itself and all related impacts, including changes in Contract Price or Contract Times. Engineer will advise Contractor in writing of any negative determination.
- C. *Special Guarantee:* Owner may require Contractor to furnish at Contractor's expense a special performance guarantee or other surety with respect to any substitute.
- D. *Reimbursement of Engineer's Cost:* Engineer will record Engineer's costs in evaluating a substitute proposed or submitted by Contractor. Whether or not Engineer approves a substitute so proposed or submitted by Contractor, Contractor shall reimburse Owner for the reasonable charges of Engineer for evaluating each such proposed substitute. Contractor shall also reimburse Owner for the reasonable charges of Engineer for making changes in the Contract Documents (or in the provisions of any other direct contract with Owner) resulting from the acceptance of each proposed substitute.
- E. *Contractor's Expense:* Contractor shall provide all data in support of any proposed substitute at Contractor's expense.
- F. *Effect of Engineer's Determination:* If Engineer approves the substitution request, Contractor shall execute the proposed Change Order and proceed with the substitution. The Engineer's denial of a substitution request shall be final and binding, and may not be reversed through an appeal under any provision of the Contract Documents. Contractor may challenge the scope of reimbursement costs imposed under Paragraph 7.05.D, by timely submittal of a Change Proposal.
- 7.06 *Concerning Subcontractors, Suppliers, and Others*
- A. Contractor may retain Subcontractors and Suppliers for the performance of parts of the Work. Such Subcontractors and Suppliers must be acceptable to Owner.
- B. Contractor shall retain specific Subcontractors, Suppliers, or other individuals or entities for the performance of designated parts of the Work if required by the Contract to do so.
- C. Subsequent to the submittal of Contractor's Bid or final negotiation of the terms of the Contract, Owner may not require Contractor to retain any Subcontractor, Supplier, or other individual or entity to furnish or perform any of the Work against which Contractor has reasonable objection.
- D. Prior to entry into any binding subcontract or purchase order, Contractor shall submit to Owner the identity of the proposed Subcontractor or Supplier (unless Owner has already deemed such proposed Subcontractor or Supplier acceptable, during the bidding process or otherwise). Such proposed Subcontractor or Supplier shall be deemed

acceptable to Owner unless Owner raises a substantive, reasonable objection within five days.

- E. Owner may require the replacement of any Subcontractor, Supplier, or other individual or entity retained by Contractor to perform any part of the Work. Owner also may require Contractor to retain specific replacements; provided, however, that Owner may not require a replacement to which Contractor has a reasonable objection. If Contractor has submitted the identity of certain Subcontractors, Suppliers, or other individuals or entities for acceptance by Owner, and Owner has accepted it (either in writing or by failing to make written objection thereto), then Owner may subsequently revoke the acceptance of any such Subcontractor, Supplier, or other individual or entity so identified solely on the basis of substantive, reasonable objection after due investigation. Contractor shall submit an acceptable replacement for the rejected Subcontractor, Supplier, or other individual or entity.
- F. If Owner requires the replacement of any Subcontractor, Supplier, or other individual or entity retained by Contractor to perform any part of the Work, then Contractor shall be entitled to an adjustment in Contract Price or Contract Times, or both, with respect to the replacement; and Contractor shall initiate a Change Proposal for such adjustment within 30 days of Owner's requirement of replacement.
- G. No acceptance by Owner of any such Subcontractor, Supplier, or other individual or entity, whether initially or as a replacement, shall constitute a waiver of the right of Owner to the completion of the Work in accordance with the Contract Documents.
- H. On a monthly basis Contractor shall submit to Engineer a complete list of all Subcontractors and Suppliers having a direct contract with Contractor, and of all other Subcontractors and Suppliers known to Contractor at the time of submittal.
- I. Contractor shall be fully responsible to Owner and Engineer for all acts and omissions of the Subcontractors, Suppliers, and other individuals or entities performing or furnishing any of the Work just as Contractor is responsible for Contractor's own acts and omissions.
- J. Contractor shall be solely responsible for scheduling and coordinating the work of

Subcontractors, Suppliers, and all other individuals or entities performing or furnishing any of the Work.

- K. Contractor shall restrict all Subcontractors, Suppliers, and such other individuals or entities performing or furnishing any of the Work from communicating with Engineer or Owner, except through Contractor or in case of an emergency, or as otherwise expressly allowed herein.
- L. The divisions and sections of the Specifications and the identifications of any Drawings shall not control Contractor in dividing the Work among Subcontractors or Suppliers or delineating the Work to be performed by any specific trade.
- M. All Work performed for Contractor by a Subcontractor or Supplier shall be pursuant to an appropriate contractual agreement that specifically binds the Subcontractor or Supplier to the applicable terms and conditions of the Contract Documents for the benefit of Owner and Engineer.
- N. Owner may furnish to any Subcontractor or Supplier, to the extent practicable, information about amounts paid to Contractor on account of Work performed for Contractor by the particular Subcontractor or Supplier.
- O. Nothing in the Contract Documents:
 - 1. shall create for the benefit of any such Subcontractor, Supplier, or other individual or entity any contractual relationship between Owner or Engineer and any such Subcontractor, Supplier, or other individual or entity; nor
 - 2. shall create any obligation on the part of Owner or Engineer to pay or to see to the payment of any money due any such Subcontractor, Supplier, or other individual or entity except as may otherwise be required by Laws and Regulations.

7.07 *Patent Fees and Royalties*

- A. Contractor shall pay all license fees and royalties and assume all costs incident to the use in the performance of the Work or the incorporation in the Work of any invention, design, process, product, or device which is the subject of patent rights or copyrights held by others. If a particular invention, design, process, product, or device is specified in the Contract Documents for use in the performance of the Work and if, to the actual

knowledge of Owner or Engineer, its use is subject to patent rights or copyrights calling for the payment of any license fee or royalty to others, the existence of such rights shall be disclosed by Owner in the Contract Documents.

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

7.08 *Permits*

- A. Unless otherwise provided in the Contract Documents, Contractor shall obtain and pay for all construction permits and licenses. Owner shall assist Contractor, when necessary, in obtaining such permits and licenses. Contractor shall pay all governmental charges and inspection fees necessary for the prosecution of the Work which are applicable at the time of the submission of Contractor's Bid (or when Contractor became bound under a negotiated contract). Owner shall pay all charges of

utility owners for connections for providing permanent service to the Work.

7.09 *Taxes*

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

7.10 *Laws and Regulations*

- A. Contractor shall give all notices required by and shall comply with all Laws and Regulations applicable to the performance of the Work. Except where otherwise expressly required by applicable Laws and Regulations, neither Owner nor Engineer shall be responsible for monitoring Contractor's compliance with any Laws or Regulations.
- B. If Contractor performs any Work or takes any other action knowing or having reason to know that it is contrary to Laws or Regulations, Contractor shall bear all resulting costs and losses, and shall indemnify and hold harmless Owner and Engineer, and the officers, directors, members, partners, employees, agents, consultants, and subcontractors of each and any of them from and against all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to such Work or other action. It shall not be Contractor's responsibility to make certain that the Work described in the Contract Documents is in accordance with Laws and Regulations, but this shall not relieve Contractor of Contractor's obligations under Paragraph 3.03.
- C. Owner or Contractor may give notice to the other party of any changes after the submission of Contractor's Bid (or after the date when Contractor became bound under a negotiated contract) in Laws or Regulations having an effect on the cost or time of performance of the Work, including but not limited to changes in Laws or Regulations having an effect on procuring permits and on sales, use, value-added, consumption, and other similar taxes. If Owner and Contractor are unable to agree on entitlement to or on the amount or extent, if any, of any adjustment in Contract Price or Contract Times resulting from such changes, then within 30 days of

such notice Contractor may submit a Change Proposal, or Owner may initiate a Claim.

7.11 *Record Documents*

- A. Contractor shall maintain in a safe place at the Site one printed record copy of all Drawings, Specifications, Addenda, Change Orders, Work Change Directives, Field Orders, written interpretations and clarifications, and approved Shop Drawings. Contractor shall keep such record documents in good order and annotate them to show changes made during construction. These record documents, together with all approved Samples, will be available to Engineer for reference. Upon completion of the Work, Contractor shall deliver these record documents to Engineer.

7.12 *Safety and Protection*

- A. Contractor shall be solely responsible for initiating, maintaining, and supervising all safety precautions and programs in connection with the Work. Such responsibility does not relieve Subcontractors of their responsibility for the safety of persons or property in the performance of their work, nor for compliance with applicable safety Laws and Regulations. Contractor shall take all necessary precautions for the safety of, and shall provide the necessary protection to prevent damage, injury, or loss to:
 - 1. all persons on the Site or who may be affected by the Work;
 - 2. all the Work and materials and equipment to be incorporated therein, whether in storage on or off the Site; and
 - 3. other property at the Site or adjacent thereto, including trees, shrubs, lawns, walks, pavements, roadways, structures, other work in progress, utilities, and Underground Facilities not designated for removal, relocation, or replacement in the course of construction.
- B. Contractor shall comply with all applicable Laws and Regulations relating to the safety of persons or property, or to the protection of persons or property from damage, injury, or loss; and shall erect and maintain all necessary safeguards for such safety and protection. Contractor shall notify Owner; the owners of adjacent property, Underground Facilities, and other utilities; and other contractors and utility owners performing work at or adjacent to the Site, when prosecution of the Work may affect them, and shall cooperate with them in the protection, removal, relocation, and

replacement of their property or work in progress.

- C. Contractor shall comply with the applicable requirements of Owner's safety programs, if any. The Supplementary Conditions identify any Owner's safety programs that are applicable to the Work.
- D. Contractor shall inform Owner and Engineer of the specific requirements of Contractor's safety program with which Owner's and Engineer's employees and representatives must comply while at the Site.
- E. All damage, injury, or loss to any property referred to in Paragraph 7.12.A.2 or 7.12.A.3 caused, directly or indirectly, in whole or in part, by Contractor, any Subcontractor, Supplier, or any other individual or entity directly or indirectly employed by any of them to perform any of the Work, or anyone for whose acts any of them may be liable, shall be remedied by Contractor at its expense (except damage or loss attributable to the fault of Drawings or Specifications or to the acts or omissions of Owner or Engineer or anyone employed by any of them, or anyone for whose acts any of them may be liable, and not attributable, directly or indirectly, in whole or in part, to the fault or negligence of Contractor or any Subcontractor, Supplier, or other individual or entity directly or indirectly employed by any of them).
- F. Contractor's duties and responsibilities for safety and protection shall continue until such time as all the Work is completed and Engineer has issued a notice to Owner and Contractor in accordance with Paragraph 15.06.B that the Work is acceptable (except as otherwise expressly provided in connection with Substantial Completion).
- G. Contractor's duties and responsibilities for safety and protection shall resume whenever Contractor or any Subcontractor or Supplier returns to the Site to fulfill warranty or correction obligations, or to conduct other tasks arising from the Contract Documents.

7.13 *Safety Representative*

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

7.14 *Hazard Communication Programs*

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

7.15 *Emergencies*

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

7.16 *Shop Drawings, Samples, and Other Submittals*

- A. Shop Drawing and Sample Submittal Requirements:

1. Before submitting a Shop Drawing or Sample, Contractor shall have:
 - a. reviewed and coordinated the Shop Drawing or Sample with other Shop Drawings and Samples and with the requirements of the Work and the Contract Documents;
 - b. determined and verified all field measurements, quantities, dimensions, specified performance and design criteria, installation requirements, materials, catalog numbers, and similar information with respect thereto;
 - c. determined and verified the suitability of all materials and equipment offered with respect to the indicated application, fabrication, shipping, handling, storage, assembly, and installation pertaining to the performance of the Work; and
 - d. determined and verified all information relative to Contractor's responsibilities for means, methods, techniques,

sequences, and procedures of construction, and safety precautions and programs incident thereto.

2. Each submittal shall bear a stamp or specific written certification that Contractor has satisfied Contractor's obligations under the Contract Documents with respect to Contractor's review of that submittal, and that Contractor approves the submittal.
3. With each submittal, Contractor shall give Engineer specific written notice of any variations that the Shop Drawing or Sample may have from the requirements of the Contract Documents. This notice shall be set forth in a written communication separate from the Shop Drawings or Sample submittal; and, in addition, in the case of Shop Drawings by a specific notation made on each Shop Drawing submitted to Engineer for review and approval of each such variation.

- B. *Submittal Procedures for Shop Drawings and Samples:* Contractor shall submit Shop Drawings and Samples to Engineer for review and approval in accordance with the accepted Schedule of Submittals. Each submittal will be identified as Engineer may require.

1. Shop Drawings:

- a. Contractor shall submit the number of copies required in the Specifications.
- b. Data shown on the Shop Drawings will be complete with respect to quantities, dimensions, specified performance and design criteria, materials, and similar data to show Engineer the services, materials, and equipment Contractor proposes to provide and to enable Engineer to review the information for the limited purposes required by Paragraph 7.16.D.

2. Samples:

- a. Contractor shall submit the number of Samples required in the Specifications.
- b. Contractor shall clearly identify each Sample as to material, Supplier, pertinent data such as catalog numbers, the use for which

intended and other data as Engineer may require to enable Engineer to review the submittal for the limited purposes required by Paragraph 7.16.D.

3. Where a Shop Drawing or Sample is required by the Contract Documents or the Schedule of Submittals, any related Work performed prior to Engineer's review and approval of the pertinent submittal will be at the sole expense and responsibility of Contractor.
- C. *Other Submittals:* Contractor shall submit other submittals to Engineer in accordance with the accepted Schedule of Submittals, and pursuant to the applicable terms of the Specifications.
- D. *Engineer's Review:*
1. Engineer will provide timely review of Shop Drawings and Samples in accordance with the Schedule of Submittals acceptable to Engineer. Engineer's review and approval will be only to determine if the items covered by the submittals will, after installation or incorporation in the Work, conform to the information given in the Contract Documents and be compatible with the design concept of the completed Project as a functioning whole as indicated by the Contract Documents.
 2. Engineer's review and approval will not extend to means, methods, techniques, sequences, or procedures of construction or to safety precautions or programs incident thereto.
 3. Engineer's review and approval of a separate item as such will not indicate approval of the assembly in which the item functions.
 4. Engineer's review and approval of a Shop Drawing or Sample shall not relieve Contractor from responsibility for any variation from the requirements of the Contract Documents unless Contractor has complied with the requirements of Paragraph 7.16.A.3 and Engineer has given written approval of each such variation by specific written notation thereof incorporated in or accompanying the Shop Drawing or Sample. Engineer will document any such approved variation from the

requirements of the Contract Documents in a Field Order.

5. Engineer's review and approval of a Shop Drawing or Sample shall not relieve Contractor from responsibility for complying with the requirements of Paragraph 7.16.A and B.
 6. Engineer's review and approval of a Shop Drawing or Sample, or of a variation from the requirements of the Contract Documents, shall not, under any circumstances, change the Contract Times or Contract Price, unless such changes are included in a Change Order.
 7. Neither Engineer's receipt, review, acceptance or approval of a Shop Drawing, Sample, or other submittal shall result in such item becoming a Contract Document.
 8. Contractor shall perform the Work in compliance with the requirements and commitments set forth in approved Shop Drawings and Samples, subject to the provisions of Paragraph 7.16.D.4.
- E. *Resubmittal Procedures:*
1. Contractor shall make corrections required by Engineer and shall return the required number of corrected copies of Shop Drawings and submit, as required, new Samples for review and approval. Contractor shall direct specific attention in writing to revisions other than the corrections called for by Engineer on previous submittals.
 2. Contractor shall furnish required submittals with sufficient information and accuracy to obtain required approval of an item with no more than three submittals. Engineer will record Engineer's time for reviewing a fourth or subsequent submittal of a Shop Drawings, sample, or other item requiring approval, and Contractor shall be responsible for Engineer's charges to Owner for such time. Owner may impose a set-off against payments due to Contractor to secure reimbursement for such charges.
 3. If Contractor requests a change of a previously approved submittal item, Contractor shall be responsible for Engineer's charges to Owner for its review time, and Owner may impose a set-off against payments due to

Contractor to secure reimbursement for such charges, unless the need for such change is beyond the control of Contractor.

7.17 *Contractor's General Warranty and Guarantee*

- A. Contractor warrants and guarantees to Owner that all Work will be in accordance with the Contract Documents and will not be defective. Engineer and its officers, directors, members, partners, employees, agents, consultants, and subcontractors shall be entitled to rely on Contractor's warranty and guarantee.
- B. Contractor's warranty and guarantee hereunder excludes defects or damage caused by:
 - 1. abuse, modification, or improper maintenance or operation by persons other than Contractor, Subcontractors, Suppliers, or any other individual or entity for whom Contractor is responsible; or
 - 2. normal wear and tear under normal usage.
- C. Contractor's obligation to perform and complete the Work in accordance with the Contract Documents shall be absolute. None of the following will constitute an acceptance of Work that is not in accordance with the Contract Documents or a release of Contractor's obligation to perform the Work in accordance with the Contract Documents:
 - 1. observations by Engineer;
 - 2. recommendation by Engineer or payment by Owner of any progress or final payment;
 - 3. the issuance of a certificate of Substantial Completion by Engineer or any payment related thereto by Owner;
 - 4. use or occupancy of the Work or any part thereof by Owner;
 - 5. any review and approval of a Shop Drawing or Sample submittal;
 - 6. the issuance of a notice of acceptability by Engineer;
 - 7. any inspection, test, or approval by others; or
 - 8. any correction of defective Work by Owner.
- D. If the Contract requires the Contractor to accept the assignment of a contract entered

into by Owner, then the specific warranties, guarantees, and correction obligations contained in the assigned contract shall govern with respect to Contractor's performance obligations to Owner for the Work described in the assigned contract.

7.18 *Indemnification*

- A. To the fullest extent permitted by Laws and Regulations, and in addition to any other obligations of Contractor under the Contract or otherwise, Contractor shall indemnify and hold harmless Owner and Engineer, and the officers, directors, members, partners, employees, agents, consultants and subcontractors of each and any of them from and against all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to the performance of the Work, provided that any such claim, cost, loss, or damage is attributable to bodily injury, sickness, disease, or death, or to injury to or destruction of tangible property (other than the Work itself), including the loss of use resulting therefrom but only to the extent caused by any negligent act or omission of Contractor, any Subcontractor, any Supplier, or any individual or entity directly or indirectly employed by any of them to perform any of the Work or anyone for whose acts any of them may be liable.
- B. In any and all claims against Owner or Engineer or any of their officers, directors, members, partners, employees, agents, consultants, or subcontractors by any employee (or the survivor or personal representative of such employee) of Contractor, any Subcontractor, any Supplier, or any individual or entity directly or indirectly employed by any of them to perform any of the Work, or anyone for whose acts any of them may be liable, the indemnification obligation under Paragraph 7.18.A shall not be limited in any way by any limitation on the amount or type of damages, compensation, or benefits payable by or for Contractor or any such Subcontractor, Supplier, or other individual or entity under workers' compensation acts, disability benefit acts, or other employee benefit acts.
- C. The indemnification obligations of Contractor under Paragraph 7.18.A shall not extend to the liability of Engineer and Engineer's officers, directors, members, partners, employees,

agents, consultants and subcontractors arising out of:

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

7.19 Delegation of Professional Design Services

- A. Contractor will not be required to provide professional design services unless such services are specifically required by the Contract Documents for a portion of the Work or unless such services are required to carry out Contractor's responsibilities for construction means, methods, techniques, sequences and procedures. Contractor shall not be required to provide professional services in violation of applicable Laws and Regulations.
- B. If professional design services or certifications by a design professional related to systems, materials, or equipment are specifically required of Contractor by the Contract Documents, Owner and Engineer will specify all performance and design criteria that such services must satisfy. Contractor shall cause such services or certifications to be provided by a properly licensed professional, whose signature and seal shall appear on all drawings, calculations, specifications, certifications, and other submittals prepared by such professional. Shop Drawings and other submittals related to the Work designed or certified by such professional, if prepared by others, shall bear such professional's written approval when submitted to Engineer.
- C. Owner and Engineer shall be entitled to rely upon the adequacy, accuracy, and completeness of the services, certifications, or approvals performed by such design professionals, provided Owner and Engineer have specified to Contractor all performance and design criteria that such services must satisfy.
- D. Pursuant to this paragraph, Engineer's review and approval of design calculations and design drawings will be only for the limited purpose of checking for conformance with performance and design criteria given and the design concept expressed in the Contract

Documents. Engineer's review and approval of Shop Drawings and other submittals (except design calculations and design drawings) will be only for the purpose stated in Paragraph 7.16.D.1.

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

ARTICLE 8 – OTHER WORK AT THE SITE

8.01 Other Work

- A. In addition to and apart from the Work under the Contract Documents, the Owner may perform other work at or adjacent to the Site. Such other work may be performed by Owner's employees, or through contracts between the Owner and third parties. Owner may also arrange to have third-party utility owners perform work on their utilities and facilities at or adjacent to the Site.
- B. If Owner performs other work at or adjacent to the Site with Owner's employees, or through contracts for such other work, then Owner shall give Contractor written notice thereof prior to starting any such other work. If Owner has advance information regarding the start of any utility work at or adjacent to the Site, Owner shall provide such information to Contractor.
- C. Contractor shall afford each other contractor that performs such other work, each utility owner performing other work, and Owner, if Owner is performing other work with Owner's employees, proper and safe access to the Site, and provide a reasonable opportunity for the introduction and storage of materials and equipment and the execution of such other work. Contractor shall do all cutting, fitting, and patching of the Work that may be required to properly connect or otherwise make its several parts come together and properly integrate with such other work. Contractor shall not endanger any work of others by cutting, excavating, or otherwise altering such work; provided, however, that Contractor may cut or alter others' work with the written consent of Engineer and the others whose work will be affected.
- D. If the proper execution or results of any part of Contractor's Work depends upon work performed by others under this Article 8, Contractor shall inspect such other work and promptly report to Engineer in writing any delays, defects, or deficiencies in such other

work that render it unavailable or unsuitable for the proper execution and results of Contractor's Work. Contractor's failure to so report will constitute an acceptance of such other work as fit and proper for integration with Contractor's Work except for latent defects and deficiencies in such other work.

8.02 *Coordination*

- A. If Owner intends to contract with others for the performance of other work at or adjacent to the Site, to perform other work at or adjacent to the Site with Owner's employees, or to arrange to have utility owners perform work at or adjacent to the Site, the following will be set forth in the Supplementary Conditions or provided to Contractor prior to the start of any such other work:
 - 1. the identity of the individual or entity that will have authority and responsibility for coordination of the activities among the various contractors;
 - 2. an itemization of the specific matters to be covered by such authority and responsibility; and
 - 3. the extent of such authority and responsibilities.
- B. Unless otherwise provided in the Supplementary Conditions, Owner shall have sole authority and responsibility for such coordination.

8.03 *Legal Relationships*

- A. If, in the course of performing other work at or adjacent to the Site for Owner, the Owner's employees, any other contractor working for Owner, or any utility owner causes damage to the Work or to the property of Contractor or its Subcontractors, or delays, disrupts, interferes with, or increases the scope or cost of the performance of the Work, through actions or inaction, then Contractor shall be entitled to an equitable adjustment in the Contract Price or the Contract Times, or both. Contractor must submit any Change Proposal seeking an equitable adjustment in the Contract Price or the Contract Times under this paragraph within 30 days of the damaging, delaying, disrupting, or interfering event. The entitlement to, and extent of, any such equitable adjustment shall take into account information (if any) regarding such other work that was provided to Contractor in the Contract Documents prior to the submittal of the Bid or the final negotiation of the terms of the Contract. When applicable, any such

equitable adjustment in Contract Price shall be conditioned on Contractor assigning to Owner all Contractor's rights against such other contractor or utility owner with respect to the damage, delay, disruption, or interference that is the subject of the adjustment. Contractor's entitlement to an adjustment of the Contract Times is conditioned on such adjustment being essential to Contractor's ability to complete the Work within the Contract Times.

- B. Contractor shall take reasonable and customary measures to avoid damaging, delaying, disrupting, or interfering with the work of Owner, any other contractor, or any utility owner performing other work at or adjacent to the Site. If Contractor fails to take such measures and as a result damages, delays, disrupts, or interferes with the work of any such other contractor or utility owner, then Owner may impose a set-off against payments due to Contractor, and assign to such other contractor or utility owner the Owner's contractual rights against Contractor with respect to the breach of the obligations set forth in this paragraph.
- C. When Owner is performing other work at or adjacent to the Site with Owner's employees, Contractor shall be liable to Owner for damage to such other work, and for the reasonable direct delay, disruption, and interference costs incurred by Owner as a result of Contractor's failure to take reasonable and customary measures with respect to Owner's other work. In response to such damage, delay, disruption, or interference, Owner may impose a set-off against payments due to Contractor.
- D. If Contractor damages, delays, disrupts, or interferes with the work of any other contractor, or any utility owner performing other work at or adjacent to the Site, through Contractor's failure to take reasonable and customary measures to avoid such impacts, or if any claim arising out of Contractor's actions, inactions, or negligence in performance of the Work at or adjacent to the Site is made by any such other contractor or utility owner against Contractor, Owner, or Engineer, then Contractor shall (1) promptly attempt to settle the claim as to all parties through negotiations with such other contractor or utility owner, or otherwise resolve the claim by arbitration or other dispute resolution proceeding or at law, and (2) indemnify and hold harmless Owner and Engineer, and the officers, directors,

members, partners, employees, agents, consultants and subcontractors of each and any of them from and against any such claims, and against all costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to such damage, delay, disruption, or interference.

ARTICLE 9 – OWNER’S RESPONSIBILITIES

9.01 *Communications to Contractor*

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

9.02 *Replacement of Engineer*

- A. Owner may at its discretion appoint an engineer to replace Engineer, provided Contractor makes no reasonable objection to the replacement engineer. The replacement engineer’s status under the Contract Documents shall be that of the former Engineer.

9.03 *Furnish Data*

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

9.04 *Pay When Due*

- A. Owner shall make payments to Contractor when they are due as provided in the Agreement.

9.05 *Lands and Easements; Reports, Tests, and Drawings*

- A. Owner’s duties with respect to providing lands and easements are set forth in Paragraph 5.01.
- B. Owner’s duties with respect to providing engineering surveys to establish reference points are set forth in Paragraph 4.03.
- C. Article 5 refers to Owner’s identifying and making available to Contractor copies of reports of explorations and tests of conditions at the Site, and drawings of physical conditions relating to existing surface or subsurface structures at the Site.

9.06 *Insurance*

- A. Owner’s responsibilities, if any, with respect to purchasing and maintaining liability and property insurance are set forth in Article 6.

9.07 *Change Orders*

- A. Owner’s responsibilities with respect to Change Orders are set forth in Article 11.

9.08 *Inspections, Tests, and Approvals*

- A. Owner’s responsibility with respect to certain inspections, tests, and approvals is set forth in Paragraph 14.02.B.

9.09 *Limitations on Owner’s Responsibilities*

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

9.10 *Undisclosed Hazardous Environmental Condition*

- A. Owner’s responsibility in respect to an undisclosed Hazardous Environmental Condition is set forth in Paragraph 5.06.

9.11 *Evidence of Financial Arrangements*

- A. Upon request of Contractor, Owner shall furnish Contractor reasonable evidence that financial arrangements have been made to satisfy Owner’s obligations under the Contract Documents (including obligations under proposed changes in the Work).

9.12 *Safety Programs*

- A. While at the Site, Owner’s employees and representatives shall comply with the specific applicable requirements of Contractor’s safety programs of which Owner has been informed.
- B. Owner shall furnish copies of any applicable Owner safety programs to Contractor.

ARTICLE 10 – ENGINEER’S STATUS DURING CONSTRUCTION

10.01 *Owner’s Representative*

- A. Engineer will be Owner’s representative during the construction period. The duties and responsibilities and the limitations of authority of Engineer as Owner’s representative during construction are set forth in the Contract.

10.02 *Visits to Site*

- A. Engineer will make visits to the Site at intervals appropriate to the various stages of construction as Engineer deems necessary in order to observe as an experienced and qualified design professional the progress that has been made and the quality of the various aspects of Contractor's executed Work. Based on information obtained during such visits and observations, Engineer, for the benefit of Owner, will determine, in general, if the Work is proceeding in accordance with the Contract Documents. Engineer will not be required to make exhaustive or continuous inspections on the Site to check the quality or quantity of the Work. Engineer's efforts will be directed toward providing for Owner a greater degree of confidence that the completed Work will conform generally to the Contract Documents. On the basis of such visits and observations, Engineer will keep Owner informed of the progress of the Work and will endeavor to guard Owner against defective Work.
- B. Engineer's visits and observations are subject to all the limitations on Engineer's authority and responsibility set forth in Paragraph 10.08. Particularly, but without limitation, during or as a result of Engineer's visits or observations of Contractor's Work, Engineer will not supervise, direct, control, or have authority over or be responsible for Contractor's means, methods, techniques, sequences, or procedures of construction, or the safety precautions and programs incident thereto, or for any failure of Contractor to comply with Laws and Regulations applicable to the performance of the Work.

10.03 *Project Representative*

- A. If Owner and Engineer have agreed that Engineer will furnish a Resident Project Representative to represent Engineer at the Site and assist Engineer in observing the progress and quality of the Work, then the authority and responsibilities of any such Resident Project Representative will be as provided in the Supplementary Conditions, and limitations on the responsibilities thereof will be as provided in Paragraph 10.08. If Owner designates another representative or agent to represent Owner at the Site who is not Engineer's consultant, agent, or employee, the responsibilities and authority and limitations thereon of such other individual or entity will be as provided in the Supplementary Conditions.

10.04 *Rejecting Defective Work*

- A. Engineer has the authority to reject Work in accordance with Article 14.

10.05 *Shop Drawings, Change Orders and Payments*

- A. Engineer's authority, and limitations thereof, as to Shop Drawings and Samples, are set forth in Paragraph 7.16.
- B. Engineer's authority, and limitations thereof, as to design calculations and design drawings submitted in response to a delegation of professional design services, if any, are set forth in Paragraph 7.19.
- C. Engineer's authority as to Change Orders is set forth in Article 11.
- D. Engineer's authority as to Applications for Payment is set forth in Article 15.

10.06 *Determinations for Unit Price Work*

- A. Engineer will determine the actual quantities and classifications of Unit Price Work performed by Contractor as set forth in Paragraph 13.03.

10.07 *Decisions on Requirements of Contract Documents and Acceptability of Work*

- A. Engineer will render decisions regarding the requirements of the Contract Documents, and judge the acceptability of the Work, pursuant to the specific procedures set forth herein for initial interpretations, Change Proposals, and acceptance of the Work. In rendering such decisions and judgments, Engineer will not show partiality to Owner or Contractor, and will not be liable to Owner, Contractor, or others in connection with any proceedings, interpretations, decisions, or judgments conducted or rendered in good faith.

10.08 *Limitations on Engineer's Authority and Responsibilities*

- A. Neither Engineer's authority or responsibility under this Article 10 or under any other provision of the Contract, nor any decision made by Engineer in good faith either to exercise or not exercise such authority or responsibility or the undertaking, exercise, or performance of any authority or responsibility by Engineer, shall create, impose, or give rise to any duty in contract, tort, or otherwise owed by Engineer to Contractor, any Subcontractor, any Supplier, any other individual or entity, or to any surety for or employee or agent of any of them.

- B. Engineer will not supervise, direct, control, or have authority over or be responsible for Contractor's means, methods, techniques, sequences, or procedures of construction, or the safety precautions and programs incident thereto, or for any failure of Contractor to comply with Laws and Regulations applicable to the performance of the Work. Engineer will not be responsible for Contractor's failure to perform the Work in accordance with the Contract Documents.
- C. Engineer will not be responsible for the acts or omissions of Contractor or of any Subcontractor, any Supplier, or of any other individual or entity performing any of the Work.
- D. Engineer's review of the final Application for Payment and accompanying documentation and all maintenance and operating instructions, schedules, guarantees, bonds, certificates of inspection, tests and approvals, and other documentation required to be delivered by Paragraph 15.06.A will only be to determine generally that their content complies with the requirements of, and in the case of certificates of inspections, tests, and approvals, that the results certified indicate compliance with the Contract Documents.
- E. The limitations upon authority and responsibility set forth in this Paragraph 10.08 shall also apply to the Resident Project Representative, if any.

10.09 *Compliance with Safety Program*

- A. While at the Site, Engineer's employees and representatives will comply with the specific applicable requirements of Owner's and Contractor's safety programs (if any) of which Engineer has been informed.

ARTICLE 11 – AMENDING THE CONTRACT DOCUMENTS; CHANGES IN THE WORK

11.01 *Amending and Supplementing Contract Documents*

- A. The Contract Documents may be amended or supplemented by a Change Order, a Work Change Directive, or a Field Order.
 - 1. Change Orders:
 - a. If an amendment or supplement to the Contract Documents includes a change in the Contract Price or the Contract Times, such amendment or supplement must be set forth in a Change Order. A Change Order

also may be used to establish amendments and supplements of the Contract Documents that do not affect the Contract Price or Contract Times.

- b. Owner and Contractor may amend those terms and conditions of the Contract Documents that do not involve (1) the performance or acceptability of the Work, (2) the design (as set forth in the Drawings, Specifications, or otherwise), or (3) other engineering or technical matters, without the recommendation of the Engineer. Such an amendment shall be set forth in a Change Order.

2. *Work Change Directives:* A Work Change Directive will not change the Contract Price or the Contract Times but is evidence that the parties expect that the modification ordered or documented by a Work Change Directive will be incorporated in a subsequently issued Change Order, following negotiations by the parties as to the Work Change Directive's effect, if any, on the Contract Price and Contract Times; or, if negotiations are unsuccessful, by a determination under the terms of the Contract Documents governing adjustments, expressly including Paragraph 11.04 regarding change of Contract Price. Contractor must submit any Change Proposal seeking an adjustment of the Contract Price or the Contract Times, or both, no later than 30 days after the completion of the Work set out in the Work Change Directive. Owner must submit any Claim seeking an adjustment of the Contract Price or the Contract Times, or both, no later than 60 days after issuance of the Work Change Directive.

3. *Field Orders:* Engineer may authorize minor changes in the Work if the changes do not involve an adjustment in the Contract Price or the Contract Times and are compatible with the design concept of the completed Project as a functioning whole as indicated by the Contract Documents. Such changes will be accomplished by a Field Order and will be binding on Owner and also on Contractor, which shall perform the Work involved promptly. If Contractor

believes that a Field Order justifies an adjustment in the Contract Price or Contract Times, or both, then before proceeding with the Work at issue, Contractor shall submit a Change Proposal as provided herein.

11.02 *Owner-Authorized Changes in the Work*

- A. Without invalidating the Contract and without notice to any surety, Owner may, at any time or from time to time, order additions, deletions, or revisions in the Work. Such changes shall be supported by Engineer's recommendation, to the extent the change involves the design (as set forth in the Drawings, Specifications, or otherwise), or other engineering or technical matters. Such changes may be accomplished by a Change Order, if Owner and Contractor have agreed as to the effect, if any, of the changes on Contract Times or Contract Price; or by a Work Change Directive. Upon receipt of any such document, Contractor shall promptly proceed with the Work involved; or, in the case of a deletion in the Work, promptly cease construction activities with respect to such deleted Work. Added or revised Work shall be performed under the applicable conditions of the Contract Documents. Nothing in this paragraph shall obligate Contractor to undertake work that Contractor reasonably concludes cannot be performed in a manner consistent with Contractor's safety obligations under the Contract Documents or Laws and Regulations.

11.03 *Unauthorized Changes in the Work*

- A. Contractor shall not be entitled to an increase in the Contract Price or an extension of the Contract Times with respect to any work performed that is not required by the Contract Documents, as amended, modified, or supplemented, except in the case of an emergency as provided in Paragraph 7.15 or in the case of uncovering Work as provided in Paragraph 14.05.

11.04 *Change of Contract Price*

- A. The Contract Price may only be changed by a Change Order. Any Change Proposal for an adjustment in the Contract Price shall comply with the provisions of Paragraph 11.06. Any Claim for an adjustment of Contract Price shall comply with the provisions of Article 12.
- B. An adjustment in the Contract Price will be determined as follows:

1. where the Work involved is covered by unit prices contained in the Contract Documents, then by application of such unit prices to the quantities of the items involved (subject to the provisions of Paragraph 13.03); or
 2. where the Work involved is not covered by unit prices contained in the Contract Documents, then by a mutually agreed lump sum (which may include an allowance for overhead and profit not necessarily in accordance with Paragraph 11.04.C.2); or
 3. where the Work involved is not covered by unit prices contained in the Contract Documents and the parties do not reach mutual agreement to a lump sum, then on the basis of the Cost of the Work (determined as provided in Paragraph 13.01) plus a Contractor's fee for overhead and profit (determined as provided in Paragraph 11.04.C).
- C. *Contractor's Fee:* When applicable, the Contractor's fee for overhead and profit shall be determined as follows:
1. a mutually acceptable fixed fee; or
 2. if a fixed fee is not agreed upon, then a fee based on the following percentages of the various portions of the Cost of the Work:
 - a. for costs incurred under Paragraphs 13.01.B.1 and 13.01.B.2, the Contractor's fee shall be 15 percent;
 - b. for costs incurred under Paragraph 13.01.B.3, the Contractor's fee shall be five percent;
 - c. where one or more tiers of subcontracts are on the basis of Cost of the Work plus a fee and no fixed fee is agreed upon, the intent of Paragraphs 11.01.C.2.a and 11.01.C.2.b is that the Contractor's fee shall be based on: (1) a fee of 15 percent of the costs incurred under Paragraphs 13.01.A.1 and 13.01.A.2 by the Subcontractor that actually performs the Work, at whatever tier, and (2) with respect to Contractor itself and to any Subcontractors of a tier higher than that of the Subcontractor that actually performs the Work, a fee of five percent of the amount (fee

plus underlying costs incurred) attributable to the next lower tier Subcontractor; provided, however, that for any such subcontracted work the maximum total fee to be paid by Owner shall be no greater than 27 percent of the costs incurred by the Subcontractor that actually performs the work;

- d. no fee shall be payable on the basis of costs itemized under Paragraphs 13.01.B.4, 13.01.B.5, and 13.01.C;
- e. the amount of credit to be allowed by Contractor to Owner for any change which results in a net decrease in cost will be the amount of the actual net decrease in cost plus a deduction in Contractor's fee by an amount equal to five percent of such net decrease; and
- f. when both additions and credits are involved in any one change, the adjustment in Contractor's fee shall be computed on the basis of the net change in accordance with Paragraphs 11.04.C.2.a through 11.04.C.2.e, inclusive.

11.05 *Change of Contract Times*

- A. The Contract Times may only be changed by a Change Order. Any Change Proposal for an adjustment in the Contract Times shall comply with the provisions of Paragraph 11.06. Any Claim for an adjustment in the Contract Times shall comply with the provisions of Article 12.
- B. An adjustment of the Contract Times shall be subject to the limitations set forth in Paragraph 4.05, concerning delays in Contractor's progress.

11.06 *Change Proposals*

- A. Contractor shall submit a Change Proposal to Engineer to request an adjustment in the Contract Times or Contract Price; appeal an initial decision by Engineer concerning the requirements of the Contract Documents or relating to the acceptability of the Work under the Contract Documents; contest a set-off against payment due; or seek other relief under the Contract. The Change Proposal shall specify any proposed change in Contract Times or Contract Price, or both, or other proposed relief, and explain the reason for the proposed change, with citations to any governing or applicable provisions of the Contract Documents.

1. *Procedures:* Contractor shall submit each Change Proposal to Engineer promptly (but in no event later than 30 days) after the start of the event giving rise thereto, or after such initial decision. The Contractor shall submit supporting data, including the proposed change in Contract Price or Contract Time (if any), to the Engineer and Owner within 15 days after the submittal of the Change Proposal. The supporting data shall be accompanied by a written statement that the supporting data are accurate and complete, and that any requested time or price adjustment is the entire adjustment to which Contractor believes it is entitled as a result of said event. Engineer will advise Owner regarding the Change Proposal, and consider any comments or response from Owner regarding the Change Proposal.

2. *Engineer's Action:* Engineer will review each Change Proposal and, within 30 days after receipt of the Contractor's supporting data, either deny the Change Proposal in whole, approve it in whole, or deny it in part and approve it in part. Such actions shall be in writing, with a copy provided to Owner and Contractor. If Engineer does not take action on the Change Proposal within 30 days, then either Owner or Contractor may at any time thereafter submit a letter to the other party indicating that as a result of Engineer's inaction the Change Proposal is deemed denied, thereby commencing the time for appeal of the denial under Article 12.

3. *Binding Decision:* Engineer's decision will be final and binding upon Owner and Contractor, unless Owner or Contractor appeals the decision by filing a Claim under Article 12.

- B. *Resolution of Certain Change Proposals:* If the Change Proposal does not involve the design (as set forth in the Drawings, Specifications, or otherwise), the acceptability of the Work, or other engineering or technical matters, then Engineer will notify the parties that the Engineer is unable to resolve the Change Proposal. For purposes of further resolution of such a Change Proposal, such notice shall be deemed a denial, and Contractor may choose to seek resolution under the terms of Article 12.

11.07 *Execution of Change Orders*

- A. Owner and Contractor shall execute appropriate Change Orders covering:
1. changes in the Contract Price or Contract Times which are agreed to by the parties, including any undisputed sum or amount of time for Work actually performed in accordance with a Work Change Directive;
 2. changes in Contract Price resulting from an Owner set-off, unless Contractor has duly contested such set-off;
 3. changes in the Work which are: (a) ordered by Owner pursuant to Paragraph 11.02, (b) required because of Owner's acceptance of defective Work under Paragraph 14.04 or Owner's correction of defective Work under Paragraph 14.07, or (c) agreed to by the parties, subject to the need for Engineer's recommendation if the change in the Work involves the design (as set forth in the Drawings, Specifications, or otherwise), or other engineering or technical matters; and
 4. changes in the Contract Price or Contract Times, or other changes, which embody the substance of any final and binding results under Paragraph 11.06, or Article 12.
- B. If Owner or Contractor refuses to execute a Change Order that is required to be executed under the terms of this Paragraph 11.07, it shall be deemed to be of full force and effect, as if fully executed.

11.08 *Notification to Surety*

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

ARTICLE 12 – CLAIMS

12.01 *Claims*

- A. *Claims Process:* The following disputes between Owner and Contractor shall be

submitted to the Claims process set forth in this Article:

1. Appeals by Owner or Contractor of Engineer's decisions regarding Change Proposals;
 2. Owner demands for adjustments in the Contract Price or Contract Times, or other relief under the Contract Documents; and
 3. Disputes that Engineer has been unable to address because they do not involve the design (as set forth in the Drawings, Specifications, or otherwise), the acceptability of the Work, or other engineering or technical matters.
- B. *Submittal of Claim:* The party submitting a Claim shall deliver it directly to the other party to the Contract promptly (but in no event later than 30 days) after the start of the event giving rise thereto; in the case of appeals regarding Change Proposals within 30 days of the decision under appeal. The party submitting the Claim shall also furnish a copy to the Engineer, for its information only. The responsibility to substantiate a Claim shall rest with the party making the Claim. In the case of a Claim by Contractor seeking an increase in the Contract Times or Contract Price, or both, Contractor shall certify that the Claim is made in good faith, that the supporting data are accurate and complete, and that to the best of Contractor's knowledge and belief the amount of time or money requested accurately reflects the full amount to which Contractor is entitled.
- C. *Review and Resolution:* The party receiving a Claim shall review it thoroughly, giving full consideration to its merits. The two parties shall seek to resolve the Claim through the exchange of information and direct negotiations. The parties may extend the time for resolving the Claim by mutual agreement. All actions taken on a Claim shall be stated in writing and submitted to the other party, with a copy to Engineer.
- D. *Mediation:*
1. At any time after initiation of a Claim, Owner and Contractor may mutually agree to mediation of the underlying dispute. The agreement to mediate shall stay the Claim submittal and response process.
 2. If Owner and Contractor agree to mediation, then after 60 days from such

agreement, either Owner or Contractor may unilaterally terminate the mediation process, and the Claim submittal and decision process shall resume as of the date of the termination. If the mediation proceeds but is unsuccessful in resolving the dispute, the Claim submittal and decision process shall resume as of the date of the conclusion of the mediation, as determined by the mediator.

3. Owner and Contractor shall each pay one-half of the mediator's fees and costs.
- E. *Partial Approval:* If the party receiving a Claim approves the Claim in part and denies it in part, such action shall be final and binding unless within 30 days of such action the other party invokes the procedure set forth in Article 17 for final resolution of disputes.
- F. *Denial of Claim:* If efforts to resolve a Claim are not successful, the party receiving the Claim may deny it by giving written notice of denial to the other party. If the receiving party does not take action on the Claim within 90 days, then either Owner or Contractor may at any time thereafter submit a letter to the other party indicating that as a result of the inaction, the Claim is deemed denied, thereby commencing the time for appeal of the denial. A denial of the Claim shall be final and binding unless within 30 days of the denial the other party invokes the procedure set forth in Article 17 for the final resolution of disputes.
- G. *Final and Binding Results:* If the parties reach a mutual agreement regarding a Claim, whether through approval of the Claim, direct negotiations, mediation, or otherwise; or if a Claim is approved in part and denied in part, or denied in full, and such actions become final and binding; then the results of the agreement or action on the Claim shall be incorporated in a Change Order to the extent they affect the Contract, including the Work, the Contract Times, or the Contract Price.

ARTICLE 13 – COST OF THE WORK; ALLOWANCES; UNIT PRICE WORK

13.01 Cost of the Work

- A. *Purposes for Determination of Cost of the Work:* The term Cost of the Work means the sum of all costs necessary for the proper performance of the Work at issue, as further defined below. The provisions of this Paragraph 13.01 are used for two distinct purposes:

1. To determine Cost of the Work when Cost of the Work is a component of the Contract Price, under cost-plus-fee, time-and-materials, or other cost-based terms; or
 2. To determine the value of a Change Order, Change Proposal, Claim, set-off, or other adjustment in Contract Price. When the value of any such adjustment is determined on the basis of Cost of the Work, Contractor is entitled only to those additional or incremental costs required because of the change in the Work or because of the event giving rise to the adjustment.
- B. *Costs Included:* Except as otherwise may be agreed to in writing by Owner, costs included in the Cost of the Work shall be in amounts no higher than those prevailing in the locality of the Project, shall not include any of the costs itemized in Paragraph 13.01.C, and shall include only the following items:
1. Payroll costs for employees in the direct employ of Contractor in the performance of the Work under schedules of job classifications agreed upon by Owner and Contractor. Such employees shall include, without limitation, superintendents, foremen, and other personnel employed full time on the Work. Payroll costs for employees not employed full time on the Work shall be apportioned on the basis of their time spent on the Work. Payroll costs shall include, but not be limited to, salaries and wages plus the cost of fringe benefits, which shall include social security contributions, unemployment, excise, and payroll taxes, workers' compensation, health and retirement benefits, bonuses, sick leave, and vacation and holiday pay applicable thereto. The expenses of performing Work outside of regular working hours, on Saturday, Sunday, or legal holidays, shall be included in the above to the extent authorized by Owner.
 2. Cost of all materials and equipment furnished and incorporated in the Work, including costs of transportation and storage thereof, and Suppliers' field services required in connection therewith. All cash discounts shall accrue to Contractor unless Owner deposits funds with Contractor with which to make payments, in which case

the cash discounts shall accrue to Owner. All trade discounts, rebates, and refunds and returns from sale of surplus materials and equipment shall accrue to Owner, and Contractor shall make provisions so that they may be obtained.

3. Payments made by Contractor to Subcontractors for Work performed by Subcontractors. If required by Owner, Contractor shall obtain competitive bids from subcontractors acceptable to Owner and Contractor and shall deliver such bids to Owner, who will then determine, with the advice of Engineer, which bids, if any, will be acceptable. If any subcontract provides that the Subcontractor is to be paid on the basis of Cost of the Work plus a fee, the Subcontractor's Cost of the Work and fee shall be determined in the same manner as Contractor's Cost of the Work and fee as provided in this Paragraph 13.01.
4. Costs of special consultants (including but not limited to engineers, architects, testing laboratories, surveyors, attorneys, and accountants) employed for services specifically related to the Work.
5. Supplemental costs including the following:
 - a. The proportion of necessary transportation, travel, and subsistence expenses of Contractor's employees incurred in discharge of duties connected with the Work.
 - b. Cost, including transportation and maintenance, of all materials, supplies, equipment, machinery, appliances, office, and temporary facilities at the Site, and hand tools not owned by the workers, which are consumed in the performance of the Work, and cost, less market value, of such items used but not consumed which remain the property of Contractor.
 - c. Rentals of all construction equipment and machinery, and the parts thereof, whether rented from Contractor or others in accordance with rental agreements approved by Owner with the advice of Engineer, and the costs of

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

- d. Sales, consumer, use, and other similar taxes related to the Work, and for which Contractor is liable, as imposed by Laws and Regulations.
- e. Deposits lost for causes other than negligence of Contractor, any Subcontractor, or anyone directly or indirectly employed by any of them or for whose acts any of them may be liable, and royalty payments and fees for permits and licenses.
- f. Losses and damages (and related expenses) caused by damage to the Work, not compensated by insurance or otherwise, sustained by Contractor in connection with the performance of the Work (except losses and damages within the deductible amounts of property insurance established in accordance with Paragraph 6.05), provided such losses and damages have resulted from causes other than the negligence of Contractor, any Subcontractor, or anyone directly or indirectly employed by any of them or for whose acts any of them may be liable. Such losses shall include settlements made with the written consent and approval of Owner. No such losses, damages, and expenses shall be included in the Cost of the Work for the purpose of determining Contractor's fee.
- g. The cost of utilities, fuel, and sanitary facilities at the Site.
- h. Minor expenses such as communication service at the Site, express and courier services, and similar petty cash items in connection with the Work.
- i. The costs of premiums for all bonds and insurance that

Contractor is required by the Contract Documents to purchase and maintain.

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

1. Payroll costs and other compensation of Contractor's officers, executives, principals (of partnerships and sole proprietorships), general managers, safety managers, engineers, architects, estimators, attorneys, auditors, accountants, purchasing and contracting agents, expeditors, timekeepers, clerks, and other personnel employed by Contractor, whether at the Site or in Contractor's principal or branch office for general administration of the Work and not specifically included in the agreed upon schedule of job classifications referred to in Paragraph 13.01.B.1 or specifically covered by Paragraph 13.01.B.4. The payroll costs and other compensation excluded here are to be considered administrative costs covered by the Contractor's fee.
2. Expenses of Contractor's principal and branch offices other than Contractor's office at the Site.
3. Any part of Contractor's capital expenses, including interest on Contractor's capital employed for the Work and charges against Contractor for delinquent payments.
4. Costs due to the negligence of Contractor, any Subcontractor, or anyone directly or indirectly employed by any of them or for whose acts any of them may be liable, including but not limited to, the correction of defective Work, disposal of materials or equipment wrongly supplied, and making good any damage to property.
5. Other overhead or general expense costs of any kind and the costs of any item not specifically and expressly included in Paragraph 13.01.B.

D. *Contractor's Fee:* When the Work as a whole is performed on the basis of cost-plus, Contractor's fee shall be determined as set forth in the Agreement. When the value of any Work covered by a Change Order, Change Proposal, Claim, set-off, or other adjustment in Contract Price is determined on the basis of

Cost of the Work, Contractor's fee shall be determined as set forth in Paragraph 11.04.C.

E. *Documentation:* Whenever the Cost of the Work for any purpose is to be determined pursuant to this Article 13, Contractor will establish and maintain records thereof in accordance with generally accepted accounting practices and submit in a form acceptable to Engineer an itemized cost breakdown together with supporting data.

13.02 Allowances

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

B. *Cash Allowances:* Contractor agrees that:

1. the cash allowances include the cost to Contractor (less any applicable trade discounts) of materials and equipment required by the allowances to be delivered at the Site, and all applicable taxes; and
2. Contractor's costs for unloading and handling on the Site, labor, installation, overhead, profit, and other expenses contemplated for the cash allowances have been included in the Contract Price and not in the allowances, and no demand for additional payment on account of any of the foregoing will be valid.

C. *Contingency Allowance:* Contractor agrees that a contingency allowance, if any, is for the sole use of Owner to cover unanticipated costs.

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

13.03 Unit Price Work

A. Where the Contract Documents provide that all or part of the Work is to be Unit Price Work, initially the Contract Price will be deemed to include for all Unit Price Work an amount equal to the sum of the unit price for each separately identified item of Unit Price Work times the estimated quantity of each item as indicated in the Agreement.

- B. The estimated quantities of items of Unit Price Work are not guaranteed and are solely for the purpose of comparison of Bids and determining an initial Contract Price. Payments to Contractor for Unit Price Work will be based on actual quantities.
- C. Each unit price will be deemed to include an amount considered by Contractor to be adequate to cover Contractor's overhead and profit for each separately identified item.
- D. Engineer will determine the actual quantities and classifications of Unit Price Work performed by Contractor. Engineer will review with Contractor the Engineer's preliminary determinations on such matters before rendering a written decision thereon (by recommendation of an Application for Payment or otherwise). Engineer's written decision thereon will be final and binding (except as modified by Engineer to reflect changed factual conditions or more accurate data) upon Owner and Contractor, subject to the provisions of the following paragraph.
- E. Within 30 days of Engineer's written decision under the preceding paragraph, Contractor may submit a Change Proposal, or Owner may file a Claim, seeking an adjustment in the Contract Price if:
 - 1. the quantity of any item of Unit Price Work performed by Contractor differs materially and significantly from the estimated quantity of such item indicated in the Agreement;
 - 2. there is no corresponding adjustment with respect to any other item of Work; and
 - 3. Contractor believes that it is entitled to an increase in Contract Price as a result of having incurred additional expense or Owner believes that Owner is entitled to a decrease in Contract Price, and the parties are unable to agree as to the amount of any such increase or decrease.

**ARTICLE 14 – TESTS AND INSPECTIONS;
CORRECTION, REMOVAL OR ACCEPTANCE OF
DEFECTIVE WORK**

14.01 Access to Work

- A. Owner, Engineer, their consultants and other representatives and personnel of Owner, independent testing laboratories, and authorities having jurisdiction will have access to the Site and the Work at reasonable

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

14.02 Tests, Inspections, and Approvals

- A. Contractor shall give Engineer timely notice of readiness of the Work (or specific parts thereof) for all required inspections and tests, and shall cooperate with inspection and testing personnel to facilitate required inspections and tests.
- B. Owner shall retain and pay for the services of an independent inspector, testing laboratory, or other qualified individual or entity to perform all inspections and tests expressly required by the Contract Documents to be furnished and paid for by Owner, except that costs incurred in connection with tests or inspections of covered Work shall be governed by the provisions of Paragraph 14.05.
- C. If Laws or Regulations of any public body having jurisdiction require any Work (or part thereof) specifically to be inspected, tested, or approved by an employee or other representative of such public body, Contractor shall assume full responsibility for arranging and obtaining such inspections, tests, or approvals, pay all costs in connection therewith, and furnish Engineer the required certificates of inspection or approval.
- D. Contractor shall be responsible for arranging, obtaining, and paying for all inspections and tests required:
 - 1. by the Contract Documents, unless the Contract Documents expressly allocate responsibility for a specific inspection or test to Owner;
 - 2. to attain Owner's and Engineer's acceptance of materials or equipment to be incorporated in the Work;
 - 3. by manufacturers of equipment furnished under the Contract Documents;
 - 4. for testing, adjusting, and balancing of mechanical, electrical, and other equipment to be incorporated into the Work; and
 - 5. for acceptance of materials, mix designs, or equipment submitted for approval

prior to Contractor's purchase thereof for incorporation in the Work.

Such inspections and tests shall be performed by independent inspectors, testing laboratories, or other qualified individuals or entities acceptable to Owner and Engineer.

- E. If the Contract Documents require the Work (or part thereof) to be approved by Owner, Engineer, or another designated individual or entity, then Contractor shall assume full responsibility for arranging and obtaining such approvals.
- F. If any Work (or the work of others) that is to be inspected, tested, or approved is covered by Contractor without written concurrence of Engineer, Contractor shall, if requested by Engineer, uncover such Work for observation. Such uncovering shall be at Contractor's expense unless Contractor had given Engineer timely notice of Contractor's intention to cover the same and Engineer had not acted with reasonable promptness in response to such notice.

14.03 *Defective Work*

- A. *Contractor's Obligation:* It is Contractor's obligation to assure that the Work is not defective.
- B. *Engineer's Authority:* Engineer has the authority to determine whether Work is defective, and to reject defective Work.
- C. *Notice of Defects:* Prompt notice of all defective Work of which Owner or Engineer has actual knowledge will be given to Contractor.
- D. *Correction, or Removal and Replacement:* Promptly after receipt of written notice of defective Work, Contractor shall correct all such defective Work, whether or not fabricated, installed, or completed, or, if Engineer has rejected the defective Work, remove it from the Project and replace it with Work that is not defective.
- E. *Preservation of Warranties:* When correcting defective Work, Contractor shall take no action that would void or otherwise impair Owner's special warranty and guarantee, if any, on said Work.
- F. *Costs and Damages:* In addition to its correction, removal, and replacement obligations with respect to defective Work, Contractor shall pay all claims, costs, losses, and damages arising out of or relating to

defective Work, including but not limited to the cost of the inspection, testing, correction, removal, replacement, or reconstruction of such defective Work, fines levied against Owner by governmental authorities because the Work is defective, and the costs of repair or replacement of work of others resulting from defective Work. Prior to final payment, if Owner and Contractor are unable to agree as to the measure of such claims, costs, losses, and damages resulting from defective Work, then Owner may impose a reasonable set-off against payments due under Article 15.

14.04 *Acceptance of Defective Work*

- A. If, instead of requiring correction or removal and replacement of defective Work, Owner prefers to accept it, Owner may do so (subject, if such acceptance occurs prior to final payment, to Engineer's confirmation that such acceptance is in general accord with the design intent and applicable engineering principles, and will not endanger public safety). Contractor shall pay all claims, costs, losses, and damages attributable to Owner's evaluation of and determination to accept such defective Work (such costs to be approved by Engineer as to reasonableness), and for the diminished value of the Work to the extent not otherwise paid by Contractor. If any such acceptance occurs prior to final payment, the necessary revisions in the Contract Documents with respect to the Work shall be incorporated in a Change Order. If the parties are unable to agree as to the decrease in the Contract Price, reflecting the diminished value of Work so accepted, then Owner may impose a reasonable set-off against payments due under Article 15. If the acceptance of defective Work occurs after final payment, Contractor shall pay an appropriate amount to Owner.

14.05 *Uncovering Work*

- A. Engineer has the authority to require special inspection or testing of the Work, whether or not the Work is fabricated, installed, or completed.
- B. If any Work is covered contrary to the written request of Engineer, then Contractor shall, if requested by Engineer, uncover such Work for Engineer's observation, and then replace the covering, all at Contractor's expense.
- C. If Engineer considers it necessary or advisable that covered Work be observed by Engineer or inspected or tested by others, then Contractor, at Engineer's request, shall uncover, expose,

or otherwise make available for observation, inspection, or testing as Engineer may require, that portion of the Work in question, and provide all necessary labor, material, and equipment.

1. If it is found that the uncovered Work is defective, Contractor shall be responsible for all claims, costs, losses, and damages arising out of or relating to such uncovering, exposure, observation, inspection, and testing, and of satisfactory replacement or reconstruction (including but not limited to all costs of repair or replacement of work of others); and pending Contractor's full discharge of this responsibility the Owner shall be entitled to impose a reasonable set-off against payments due under Article 15.
2. If the uncovered Work is not found to be defective, Contractor shall be allowed an increase in the Contract Price or an extension of the Contract Times, or both, directly attributable to such uncovering, exposure, observation, inspection, testing, replacement, and reconstruction. If the parties are unable to agree as to the amount or extent thereof, then Contractor may submit a Change Proposal within 30 days of the determination that the Work is not defective.

14.06 *Owner May Stop the Work*

- A. If the Work is defective, or Contractor fails to supply sufficient skilled workers or suitable materials or equipment, or fails to perform the Work in such a way that the completed Work will conform to the Contract Documents, then Owner may order Contractor to stop the Work, or any portion thereof, until the cause for such order has been eliminated; however, this right of Owner to stop the Work shall not give rise to any duty on the part of Owner to exercise this right for the benefit of Contractor, any Subcontractor, any Supplier, any other individual or entity, or any surety for, or employee or agent of any of them.

14.07 *Owner May Correct Defective Work*

- A. If Contractor fails within a reasonable time after written notice from Engineer to correct defective Work, or to remove and replace rejected Work as required by Engineer, or if Contractor fails to perform the Work in accordance with the Contract Documents, or if Contractor fails to comply with any other

provision of the Contract Documents, then Owner may, after seven days written notice to Contractor, correct or remedy any such deficiency.

- B. In exercising the rights and remedies under this Paragraph 14.07, Owner shall proceed expeditiously. In connection with such corrective or remedial action, Owner may exclude Contractor from all or part of the Site, take possession of all or part of the Work and suspend Contractor's services related thereto, and incorporate in the Work all materials and equipment stored at the Site or for which Owner has paid Contractor but which are stored elsewhere. Contractor shall allow Owner, Owner's representatives, agents and employees, Owner's other contractors, and Engineer and Engineer's consultants access to the Site to enable Owner to exercise the rights and remedies under this paragraph.
- C. All claims, costs, losses, and damages incurred or sustained by Owner in exercising the rights and remedies under this Paragraph 14.07 will be charged against Contractor as set-offs against payments due under Article 15. Such claims, costs, losses and damages will include but not be limited to all costs of repair, or replacement of work of others destroyed or damaged by correction, removal, or replacement of Contractor's defective Work.
- D. Contractor shall not be allowed an extension of the Contract Times because of any delay in the performance of the Work attributable to the exercise by Owner of Owner's rights and remedies under this Paragraph 14.07.

ARTICLE 15 – PAYMENTS TO CONTRACTOR; SET-OFFS; COMPLETION; CORRECTION PERIOD

15.01 *Progress Payments*

- A. *Basis for Progress Payments:* The Schedule of Values established as provided in Article 2 will serve as the basis for progress payments and will be incorporated into a form of Application for Payment acceptable to Engineer. Progress payments on account of Unit Price Work will be based on the number of units completed during the pay period, as determined under the provisions of Paragraph 13.03. Progress payments for cost-based Work will be based on Cost of the Work completed by Contractor during the pay period.

B. Applications for Payments:

1. At least 20 days before the date established in the Agreement for each progress payment (but not more often than once a month), Contractor shall submit to Engineer for review an Application for Payment filled out and signed by Contractor covering the Work completed as of the date of the Application and accompanied by such supporting documentation as is required by the Contract Documents. If payment is requested on the basis of materials and equipment not incorporated in the Work but delivered and suitably stored at the Site or at another location agreed to in writing, the Application for Payment shall also be accompanied by a bill of sale, invoice, or other documentation warranting that Owner has received the materials and equipment free and clear of all Liens, and evidence that the materials and equipment are covered by appropriate property insurance, a warehouse bond, or other arrangements to protect Owner's interest therein, all of which must be satisfactory to Owner.
2. Beginning with the second Application for Payment, each Application shall include an affidavit of Contractor stating that all previous progress payments received on account of the Work have been applied on account to discharge Contractor's legitimate obligations associated with prior Applications for Payment.
3. The amount of retainage with respect to progress payments will be as stipulated in the Agreement.

C. Review of Applications:

1. Engineer will, within 10 days after receipt of each Application for Payment, including each resubmittal, either indicate in writing a recommendation of payment and present the Application to Owner, or return the Application to Contractor indicating in writing Engineer's reasons for refusing to recommend payment. In the latter case, Contractor may make the necessary corrections and resubmit the Application.
2. Engineer's recommendation of any payment requested in an Application for Payment will constitute a representation

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

- a. the Work has progressed to the point indicated;
 - b. the quality of the Work is generally in accordance with the Contract Documents (subject to an evaluation of the Work as a functioning whole prior to or upon Substantial Completion, the results of any subsequent tests called for in the Contract Documents, a final determination of quantities and classifications for Unit Price Work under Paragraph 13.03, and any other qualifications stated in the recommendation); and
 - c. the conditions precedent to Contractor's being entitled to such payment appear to have been fulfilled in so far as it is Engineer's responsibility to observe the Work.
3. By recommending any such payment Engineer will not thereby be deemed to have represented that:
 - a. inspections made to check the quality or the quantity of the Work as it has been performed have been exhaustive, extended to every aspect of the Work in progress, or involved detailed inspections of the Work beyond the responsibilities specifically assigned to Engineer in the Contract; or
 - b. there may not be other matters or issues between the parties that might entitle Contractor to be paid additionally by Owner or entitle Owner to withhold payment to Contractor.
 4. Neither Engineer's review of Contractor's Work for the purposes of recommending payments nor Engineer's recommendation of any payment, including final payment, will impose responsibility on Engineer:
 - a. to supervise, direct, or control the Work, or

- b. for the means, methods, techniques, sequences, or procedures of construction, or the safety precautions and programs incident thereto, or
 - c. for Contractor's failure to comply with Laws and Regulations applicable to Contractor's performance of the Work, or
 - d. to make any examination to ascertain how or for what purposes Contractor has used the money paid on account of the Contract Price, or
 - e. to determine that title to any of the Work, materials, or equipment has passed to Owner free and clear of any Liens.
 - 5. Engineer may refuse to recommend the whole or any part of any payment if, in Engineer's opinion, it would be incorrect to make the representations to Owner stated in Paragraph 15.01.C.2.
 - 6. Engineer will recommend reductions in payment (set-offs) necessary in Engineer's opinion to protect Owner from loss because:
 - a. the Work is defective, requiring correction or replacement;
 - b. the Contract Price has been reduced by Change Orders;
 - c. Owner has been required to correct defective Work in accordance with Paragraph 14.07, or has accepted defective Work pursuant to Paragraph 14.04;
 - d. Owner has been required to remove or remediate a Hazardous Environmental Condition for which Contractor is responsible; or
 - e. Engineer has actual knowledge of the occurrence of any of the events that would constitute a default by Contractor and therefore justify termination for cause under the Contract Documents.
- D. Payment Becomes Due:
- 1. Ten days after presentation of the Application for Payment to Owner with Engineer's recommendation, the amount recommended (subject to any Owner set-offs) will become due, and when due will be paid by Owner to Contractor.
- E. Reductions in Payment by Owner:
- 1. In addition to any reductions in payment (set-offs) recommended by Engineer, Owner is entitled to impose a set-off against payment based on any of the following:
 - a. claims have been made against Owner on account of Contractor's conduct in the performance or furnishing of the Work, or Owner has incurred costs, losses, or damages on account of Contractor's conduct in the performance or furnishing of the Work, including but not limited to claims, costs, losses, or damages from workplace injuries, adjacent property damage, non-compliance with Laws and Regulations, and patent infringement;
 - b. Contractor has failed to take reasonable and customary measures to avoid damage, delay, disruption, and interference with other work at or adjacent to the Site;
 - c. Contractor has failed to provide and maintain required bonds or insurance;
 - d. Owner has been required to remove or remediate a Hazardous Environmental Condition for which Contractor is responsible;
 - e. Owner has incurred extra charges or engineering costs related to submittal reviews, evaluations of proposed substitutes, tests and inspections, or return visits to manufacturing or assembly facilities;
 - f. the Work is defective, requiring correction or replacement;
 - g. Owner has been required to correct defective Work in accordance with Paragraph 14.07, or has accepted defective Work pursuant to Paragraph 14.04;
 - h. the Contract Price has been reduced by Change Orders;

- i. an event that would constitute a default by Contractor and therefore justify a termination for cause has occurred;
 - j. liquidated damages have accrued as a result of Contractor's failure to achieve Milestones, Substantial Completion, or final completion of the Work;
 - k. Liens have been filed in connection with the Work, except where Contractor has delivered a specific bond satisfactory to Owner to secure the satisfaction and discharge of such Liens;
 - l. there are other items entitling Owner to a set off against the amount recommended.
2. If Owner imposes any set-off against payment, whether based on its own knowledge or on the written recommendations of Engineer, Owner will give Contractor immediate written notice (with a copy to Engineer) stating the reasons for such action and the specific amount of the reduction, and promptly pay Contractor any amount remaining after deduction of the amount so withheld. Owner shall promptly pay Contractor the amount so withheld, or any adjustment thereto agreed to by Owner and Contractor, if Contractor remedies the reasons for such action. The reduction imposed shall be binding on Contractor unless it duly submits a Change Proposal contesting the reduction.
 3. Upon a subsequent determination that Owner's refusal of payment was not justified, the amount wrongfully withheld shall be treated as an amount due as determined by Paragraph 15.01.C.1 and subject to interest as provided in the Agreement.

15.02 *Contractor's Warranty of Title*

- A. Contractor warrants and guarantees that title to all Work, materials, and equipment furnished under the Contract will pass to Owner free and clear of (1) all Liens and other title defects, and (2) all patent, licensing, copyright, or royalty obligations, no later than seven days after the time of payment by Owner.

15.03 *Substantial Completion*

- A. When Contractor considers the entire Work ready for its intended use Contractor shall notify Owner and Engineer in writing that the entire Work is substantially complete and request that Engineer issue a certificate of Substantial Completion. Contractor shall at the same time submit to Owner and Engineer an initial draft of punch list items to be completed or corrected before final payment.
- B. Promptly after Contractor's notification, Owner, Contractor, and Engineer shall make an inspection of the Work to determine the status of completion. If Engineer does not consider the Work substantially complete, Engineer will notify Contractor in writing giving the reasons therefor.
- C. If Engineer considers the Work substantially complete, Engineer will deliver to Owner a preliminary certificate of Substantial Completion which shall fix the date of Substantial Completion. Engineer shall attach to the certificate a punch list of items to be completed or corrected before final payment. Owner shall have seven days after receipt of the preliminary certificate during which to make written objection to Engineer as to any provisions of the certificate or attached punch list. If, after considering the objections to the provisions of the preliminary certificate, Engineer concludes that the Work is not substantially complete, Engineer will, within 14 days after submission of the preliminary certificate to Owner, notify Contractor in writing that the Work is not substantially complete, stating the reasons therefor. If Owner does not object to the provisions of the certificate, or if despite consideration of Owner's objections Engineer concludes that the Work is substantially complete, then Engineer will, within said 14 days, execute and deliver to Owner and Contractor a final certificate of Substantial Completion (with a revised punch list of items to be completed or corrected) reflecting such changes from the preliminary certificate as Engineer believes justified after consideration of any objections from Owner.
- D. At the time of receipt of the preliminary certificate of Substantial Completion, Owner and Contractor will confer regarding Owner's use or occupancy of the Work following Substantial Completion, review the builder's risk insurance policy with respect to the end of the builder's risk coverage, and confirm the transition to coverage of the Work under a

permanent property insurance policy held by Owner. Unless Owner and Contractor agree otherwise in writing, Owner shall bear responsibility for security, operation, protection of the Work, property insurance, maintenance, heat, and utilities upon Owner's use or occupancy of the Work.

- E. After Substantial Completion the Contractor shall promptly begin work on the punch list of items to be completed or corrected prior to final payment. In appropriate cases Contractor may submit monthly Applications for Payment for completed punch list items, following the progress payment procedures set forth above.
- F. Owner shall have the right to exclude Contractor from the Site after the date of Substantial Completion subject to allowing Contractor reasonable access to remove its property and complete or correct items on the punch list.

15.04 *Partial Use or Occupancy*

- A. Prior to Substantial Completion of all the Work, Owner may use or occupy any substantially completed part of the Work which has specifically been identified in the Contract Documents, or which Owner, Engineer, and Contractor agree constitutes a separately functioning and usable part of the Work that can be used by Owner for its intended purpose without significant interference with Contractor's performance of the remainder of the Work, subject to the following conditions:
 - 1. At any time Owner may request in writing that Contractor permit Owner to use or occupy any such part of the Work that Owner believes to be substantially complete. If and when Contractor agrees that such part of the Work is substantially complete, Contractor, Owner, and Engineer will follow the procedures of Paragraph 15.03.A through E for that part of the Work.
 - 2. At any time Contractor may notify Owner and Engineer in writing that Contractor considers any such part of the Work substantially complete and request Engineer to issue a certificate of Substantial Completion for that part of the Work.
 - 3. Within a reasonable time after either such request, Owner, Contractor, and Engineer shall make an inspection of that

part of the Work to determine its status of completion. If Engineer does not consider that part of the Work to be substantially complete, Engineer will notify Owner and Contractor in writing giving the reasons therefor. If Engineer considers that part of the Work to be substantially complete, the provisions of Paragraph 15.03 will apply with respect to certification of Substantial Completion of that part of the Work and the division of responsibility in respect thereof and access thereto.

- 4. No use or occupancy or separate operation of part of the Work may occur prior to compliance with the requirements of Paragraph 6.05 regarding builder's risk or other property insurance.

15.05 *Final Inspection*

- A. Upon written notice from Contractor that the entire Work or an agreed portion thereof is complete, Engineer will promptly make a final inspection with Owner and Contractor and will notify Contractor in writing of all particulars in which this inspection reveals that the Work, or agreed portion thereof, is incomplete or defective. Contractor shall immediately take such measures as are necessary to complete such Work or remedy such deficiencies.

15.06 *Final Payment*

- A. Application for Payment:
 - 1. After Contractor has, in the opinion of Engineer, satisfactorily completed all corrections identified during the final inspection and has delivered, in accordance with the Contract Documents, all maintenance and operating instructions, schedules, guarantees, bonds, certificates or other evidence of insurance, certificates of inspection, annotated record documents (as provided in Paragraph 7.11), and other documents, Contractor may make application for final payment.
 - 2. The final Application for Payment shall be accompanied (except as previously delivered) by:
 - a. all documentation called for in the Contract Documents;
 - b. consent of the surety, if any, to final payment;

- c. satisfactory evidence that all title issues have been resolved such that title to all Work, materials, and equipment has passed to Owner free and clear of any Liens or other title defects, or will so pass upon final payment.
 - d. a list of all disputes that Contractor believes are unsettled; and
 - e. complete and legally effective releases or waivers (satisfactory to Owner) of all Lien rights arising out of the Work, and of Liens filed in connection with the Work.
- 3. In lieu of the releases or waivers of Liens specified in Paragraph 15.06.A.2 and as approved by Owner, Contractor may furnish receipts or releases in full and an affidavit of Contractor that: (a) the releases and receipts include all labor, services, material, and equipment for which a Lien could be filed; and (b) all payrolls, material and equipment bills, and other indebtedness connected with the Work for which Owner might in any way be responsible, or which might in any way result in liens or other burdens on Owner's property, have been paid or otherwise satisfied. If any Subcontractor or Supplier fails to furnish such a release or receipt in full, Contractor may furnish a bond or other collateral satisfactory to Owner to indemnify Owner against any Lien, or Owner at its option may issue joint checks payable to Contractor and specified Subcontractors and Suppliers.
- B. Engineer's Review of Application and Acceptance:
 - 1. If, on the basis of Engineer's observation of the Work during construction and final inspection, and Engineer's review of the final Application for Payment and accompanying documentation as required by the Contract Documents, Engineer is satisfied that the Work has been completed and Contractor's other obligations under the Contract have been fulfilled, Engineer will, within ten days after receipt of the final Application for Payment, indicate in writing Engineer's recommendation of final payment and present the Application for Payment to Owner for payment. Such recommendation shall account for any set-offs against payment that are

necessary in Engineer's opinion to protect Owner from loss for the reasons stated above with respect to progress payments. At the same time Engineer will also give written notice to Owner and Contractor that the Work is acceptable, subject to the provisions of Paragraph 15.07. Otherwise, Engineer will return the Application for Payment to Contractor, indicating in writing the reasons for refusing to recommend final payment, in which case Contractor shall make the necessary corrections and resubmit the Application for Payment.

- C. *Completion of Work*: The Work is complete (subject to surviving obligations) when it is ready for final payment as established by the Engineer's written recommendation of final payment.
- D. *Payment Becomes Due*: Thirty days after the presentation to Owner of the final Application for Payment and accompanying documentation, the amount recommended by Engineer (less any further sum Owner is entitled to set off against Engineer's recommendation, including but not limited to set-offs for liquidated damages and set-offs allowed under the provisions above with respect to progress payments) will become due and shall be paid by Owner to Contractor.

15.07 *Waiver of Claims*

- A. The making of final payment will not constitute a waiver by Owner of claims or rights against Contractor. Owner expressly reserves claims and rights arising from unsettled Liens, from defective Work appearing after final inspection pursuant to Paragraph 15.05, from Contractor's failure to comply with the Contract Documents or the terms of any special guarantees specified therein, from outstanding Claims by Owner, or from Contractor's continuing obligations under the Contract Documents.
- B. The acceptance of final payment by Contractor will constitute a waiver by Contractor of all claims and rights against Owner other than those pending matters that have been duly submitted or appealed under the provisions of Article 17.

15.08 *Correction Period*

- A. If within one year after the date of Substantial Completion (or such longer period of time as may be prescribed by the terms of any applicable special guarantee required by the

Contract Documents, or by any specific provision of the Contract Documents), any Work is found to be defective, or if the repair of any damages to the Site, adjacent areas that Contractor has arranged to use through construction easements or otherwise, and other adjacent areas used by Contractor as permitted by Laws and Regulations, is found to be defective, then Contractor shall promptly, without cost to Owner and in accordance with Owner's written instructions:

1. correct the defective repairs to the Site or such other adjacent areas;
 2. correct such defective Work;
 3. if the defective Work has been rejected by Owner, remove it from the Project and replace it with Work that is not defective, and
 4. satisfactorily correct or repair or remove and replace any damage to other Work, to the work of others, or to other land or areas resulting therefrom.
- B. If Contractor does not promptly comply with the terms of Owner's written instructions, or in an emergency where delay would cause serious risk of loss or damage, Owner may have the defective Work corrected or repaired or may have the rejected Work removed and replaced. Contractor shall pay all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to such correction or repair or such removal and replacement (including but not limited to all costs of repair or replacement of work of others).
- C. In special circumstances where a particular item of equipment is placed in continuous service before Substantial Completion of all the Work, the correction period for that item may start to run from an earlier date if so provided in the Specifications.
- D. Where defective Work (and damage to other Work resulting therefrom) has been corrected or removed and replaced under this paragraph, the correction period hereunder with respect to such Work will be extended for an additional period of one year after such correction or removal and replacement has been satisfactorily completed.
- E. Contractor's obligations under this paragraph are in addition to all other obligations and

warranties. The provisions of this paragraph shall not be construed as a substitute for, or a waiver of, the provisions of any applicable statute of limitation or repose.

ARTICLE 16 – SUSPENSION OF WORK AND TERMINATION

16.01 *Owner May Suspend Work*

- A. At any time and without cause, Owner may suspend the Work or any portion thereof for a period of not more than 90 consecutive days by written notice to Contractor and Engineer. Such notice will fix the date on which Work will be resumed. Contractor shall resume the Work on the date so fixed. Contractor shall be entitled to an adjustment in the Contract Price or an extension of the Contract Times, or both, directly attributable to any such suspension. Any Change Proposal seeking such adjustments shall be submitted no later than 30 days after the date fixed for resumption of Work.

16.02 *Owner May Terminate for Cause*

- A. The occurrence of any one or more of the following events will constitute a default by Contractor and justify termination for cause:
1. Contractor's persistent failure to perform the Work in accordance with the Contract Documents (including, but not limited to, failure to supply sufficient skilled workers or suitable materials or equipment or failure to adhere to the Progress Schedule);
 2. Failure of Contractor to perform or otherwise to comply with a material term of the Contract Documents;
 3. Contractor's disregard of Laws or Regulations of any public body having jurisdiction; or
 4. Contractor's repeated disregard of the authority of Owner or Engineer.
- B. If one or more of the events identified in Paragraph 16.02.A occurs, then after giving Contractor (and any surety) ten days written notice that Owner is considering a declaration that Contractor is in default and termination of the contract, Owner may proceed to:
1. declare Contractor to be in default, and give Contractor (and any surety) notice that the Contract is terminated; and

- 2. enforce the rights available to Owner under any applicable performance bond.
- C. Subject to the terms and operation of any applicable performance bond, if Owner has terminated the Contract for cause, Owner may exclude Contractor from the Site, take possession of the Work, incorporate in the Work all materials and equipment stored at the Site or for which Owner has paid Contractor but which are stored elsewhere, and complete the Work as Owner may deem expedient.
- D. Owner may not proceed with termination of the Contract under Paragraph 16.02.B if Contractor within seven days of receipt of notice of intent to terminate begins to correct its failure to perform and proceeds diligently to cure such failure.
- E. If Owner proceeds as provided in Paragraph 16.02.B, Contractor shall not be entitled to receive any further payment until the Work is completed. If the unpaid balance of the Contract Price exceeds the cost to complete the Work, including all related claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals) sustained by Owner, such excess will be paid to Contractor. If the cost to complete the Work including such related claims, costs, losses, and damages exceeds such unpaid balance, Contractor shall pay the difference to Owner. Such claims, costs, losses, and damages incurred by Owner will be reviewed by Engineer as to their reasonableness and, when so approved by Engineer, incorporated in a Change Order. When exercising any rights or remedies under this paragraph, Owner shall not be required to obtain the lowest price for the Work performed.
- F. Where Contractor's services have been so terminated by Owner, the termination will not affect any rights or remedies of Owner against Contractor then existing or which may thereafter accrue, or any rights or remedies of Owner against Contractor or any surety under any payment bond or performance bond. Any retention or payment of money due Contractor by Owner will not release Contractor from liability.
- G. If and to the extent that Contractor has provided a performance bond under the provisions of Paragraph 6.01.A, the provisions of that bond shall govern over any inconsistent provisions of Paragraphs 16.02.B and 16.02.D.

16.03 *Owner May Terminate For Convenience*

- A. Upon seven days written notice to Contractor and Engineer, Owner may, without cause and without prejudice to any other right or remedy of Owner, terminate the Contract. In such case, Contractor shall be paid for (without duplication of any items):
 - 1. completed and acceptable Work executed in accordance with the Contract Documents prior to the effective date of termination, including fair and reasonable sums for overhead and profit on such Work;
 - 2. expenses sustained prior to the effective date of termination in performing services and furnishing labor, materials, or equipment as required by the Contract Documents in connection with uncompleted Work, plus fair and reasonable sums for overhead and profit on such expenses; and
 - 3. other reasonable expenses directly attributable to termination, including costs incurred to prepare a termination for convenience cost proposal.
- B. Contractor shall not be paid on account of loss of anticipated overhead, profits, or revenue, or other economic loss arising out of or resulting from such termination.

16.04 *Contractor May Stop Work or Terminate*

- A. If, through no act or fault of Contractor, (1) the Work is suspended for more than 90 consecutive days by Owner or under an order of court or other public authority, or (2) Engineer fails to act on any Application for Payment within 30 days after it is submitted, or (3) Owner fails for 30 days to pay Contractor any sum finally determined to be due, then Contractor may, upon seven days written notice to Owner and Engineer, and provided Owner or Engineer do not remedy such suspension or failure within that time, terminate the contract and recover from Owner payment on the same terms as provided in Paragraph 16.03.
- B. In lieu of terminating the Contract and without prejudice to any other right or remedy, if Engineer has failed to act on an Application for Payment within 30 days after it is submitted, or Owner has failed for 30 days to pay Contractor any sum finally determined to be due, Contractor may, seven days after written notice to Owner and Engineer, stop the Work until payment is made of all such

amounts due Contractor, including interest thereon. The provisions of this paragraph are not intended to preclude Contractor from submitting a Change Proposal for an adjustment in Contract Price or Contract Times or otherwise for expenses or damage directly attributable to Contractor's stopping the Work as permitted by this paragraph.

ARTICLE 17 – FINAL RESOLUTION OF DISPUTES

17.01 *Methods and Procedures*

- A. *Disputes Subject to Final Resolution:* The following disputed matters are subject to final resolution under the provisions of this Article:
 - 1. A timely appeal of an approval in part and denial in part of a Claim, or of a denial in full; and
 - 2. Disputes between Owner and Contractor concerning the Work or obligations under the Contract Documents, and arising after final payment has been made.
- B. *Final Resolution of Disputes:* For any dispute subject to resolution under this Article, Owner or Contractor may:
 - 1. elect in writing to invoke the dispute resolution process provided for in the Supplementary Conditions; or
 - 2. agree with the other party to submit the dispute to another dispute resolution process; or
 - 3. if no dispute resolution process is provided for in the Supplementary Conditions or mutually agreed to, give written notice to the other party of the intent to submit the dispute to a court of competent jurisdiction.

ARTICLE 18 – MISCELLANEOUS

18.01 *Giving Notice*

- A. Whenever any provision of the Contract Documents requires the giving of written notice, it will be deemed to have been validly given if:
 - 1. delivered in person, by a commercial courier service or otherwise, to the individual or to a member of the firm or to an officer of the corporation for which it is intended; or

- 2. delivered at or sent by registered or certified mail, postage prepaid, to the last business address known to the sender of the notice.

18.02 *Computation of Times*

- A. When any period of time is referred to in the Contract by days, it will be computed to exclude the first and include the last day of such period. If the last day of any such period falls on a Saturday or Sunday or on a day made a legal holiday by the law of the applicable jurisdiction, such day will be omitted from the computation.

18.03 *Cumulative Remedies*

- A. The duties and obligations imposed by these General Conditions and the rights and remedies available hereunder to the parties hereto are in addition to, and are not to be construed in any way as a limitation of, any rights and remedies available to any or all of them which are otherwise imposed or available by Laws or Regulations, by special warranty or guarantee, or by other provisions of the Contract. The provisions of this paragraph will be as effective as if repeated specifically in the Contract Documents in connection with each particular duty, obligation, right, and remedy to which they apply.

18.04 *Limitation of Damages*

- A. With respect to any and all Change Proposals, Claims, disputes subject to final resolution, and other matters at issue, neither Owner nor Engineer, nor any of their officers, directors, members, partners, employees, agents, consultants, or subcontractors, shall be liable to Contractor for any claims, costs, losses, or damages sustained by Contractor on or in connection with any other project or anticipated project.

18.05 *No Waiver*

- A. A party's non-enforcement of any provision shall not constitute a waiver of that provision, nor shall it affect the enforceability of that provision or of the remainder of this Contract.

18.06 *Survival of Obligations*

- A. All representations, indemnifications, warranties, and guarantees made in, required by, or given in accordance with the Contract, as well as all continuing obligations indicated in the Contract, will survive final payment, completion, and acceptance of the Work or

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

18.07 *Controlling Law*

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

18.08 *Headings*

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

SUPPLEMENTARY CONDITIONS

These Supplementary Conditions amend or supplement the Standard General Conditions of the Construction Contract as indicated below. All provisions that are not so amended or supplemented remain in full force and effect.

The terms used in these Supplementary Conditions have the meanings stated in the General Conditions. Additional terms used in these Supplementary Conditions have the meanings stated below, which are applicable to both the singular and plural thereof. The address system used in these Supplementary Conditions is the same as the address system used in the General Conditions, with the prefix “SC” added thereto.

SC-1.01. Renumber Paragraph 1.01.A.38 to 1.01.A.38.a, and add the following new paragraphs:

1.01.A.38.b. *Specialist*—The term Specialist refers to a person, partnership, firm, or corporation of established reputation (or if newly organized, whose personnel have previously established a reputation in the same field), which is regularly engaged in, and which maintains a regular force of workers skilled in either (as applicable) manufacturing or fabricating items required by the Contract Documents, or otherwise performing Work required by the Contract Documents. Where the Specifications require the installation by a Specialist, that term shall also be deemed to mean either the manufacturer of the item, a person, partnership, firm, or corporation licensed by the manufacturer, or a person, partnership, firm, or corporation who will perform the Work under the manufacturer’s direct supervision.

1.01.A.38.c. *Standard Specifications*—Wherever in these Contract Documents reference is made to the Standard Specifications, said reference shall be understood as referring to the Technical Specifications which applicable parts are incorporated herein and made a part of these Documents by specific reference thereto. If requirements contained in the Standard Specifications are modified by or are in conflict with supplemental information in these Contract Documents, the requirements of these Contract Documents shall prevail.

SC-1.01. Add the following language at the end of Paragraph 1.01.A.40:

Substantial Completion is further defined as (i) that degree of completion of the Project’s operating facilities or systems sufficient to provide Owner the full time, uninterrupted, and continuous beneficial operation of the Work; and (ii) required functional, performance and acceptance, or startup testing has been successfully demonstrated for components, devices, equipment, and instrumentation and control to the satisfaction of Engineer in accordance with the requirements of the Specifications.

SC-2.01 Delete Paragraph 2.01.B. and Paragraph 2.01.C. in their entirety and insert the following in their place:

2.01.B. Evidence of Contractor's Insurance: When Contractor delivers the executed counterparts of the Agreement to Owner, Contractor shall also deliver to Owner copies of the policies of insurance (including all endorsements, and identification of applicable self-insured retentions and deductibles) required to be provided by Contractor in Article 6. Contractor may block out (redact) any confidential premium or pricing information contained in any policy or endorsement furnished under this provision.

SC-2.02. Delete Paragraph 2.02.A. in its entirety and insert the following new paragraph in its place:

2.02.A. Owner shall furnish to Contractor two copies of conformed Contract Documents incorporating and integrating all Addenda and any amendments negotiated prior to the Effective Date of the Contract (including one fully executed counterpart of the Agreement) and one copy in electronic portable document format (PDF). One of the two copies shall be used by the Contractor as the record document set, and the Contractor shall indicate on this set all changes made during construction. Additional printed copies of the conformed Contract Documents will be furnished upon request at the cost of reproduction.

SC-3.01. Delete Paragraph 3.01.C in its entirety.

SC-3.01. Add the following new paragraph immediately after Paragraph 3.01.E:

3.01.F. Sections of Division 01, General Requirements, govern the execution of the Work of all sections of the Specifications.

SC-5.03 Add the following new paragraphs immediately after Paragraph 5.03.B:

5.03.C. The following reports of explorations and tests of subsurface conditions at or adjacent to the Site are known to Owner:

5.03.C.1. Report dated 1997 prepared by Mallett and Associates, Inc, entitled "Report of Subsurface Exploration and Geotechnical Engineering Evaluation, Proposed South Fayette Water Treatment Plant, Antioch Road, Fayette County, Georgia, PCG Project No. 97128". The Technical Data contained in such report upon whose accuracy Contractor may rely are those indicated in the definition of Technical Data in the General Conditions.

5.03.D. The following drawings of physical conditions relating to existing surface or subsurface structures at or adjacent to the Site (except Underground Facilities) are known to Owner:

5.03.D.1. Drawings dated January 2002 prepared by Mallett and Associates, Inc, entitled "South Fayette County Water Treatment Plant".

5.03.D.2. Drawings dated August 2014 prepared by CH2M Hill, entitled "Chemical Systems and Actuator Improvements".

5.03.D.1.a. All of the information in such drawings constitutes Technical Data on whose accuracy Contractor may rely.

5.03.E. Contractor may examine copies of reports and drawings identified in SC-5.03.C and SC-5.03.D that were not included with the Bidding Documents at the Fayette County Purchasing Department during regular business hours.

SC-5.06. Delete Paragraph 5.06.A and Paragraph 5.06.B in their entirety and insert the following in their place:

5.06.A. No reports or drawings related to Hazardous Environmental Conditions are known to Owner.

SC-6.01. Change Paragraph 6.01.D to read as follows:

"...above, then Contractor shall promptly notify Owner and Engineer and shall, within 10 days after the event giving rise to such notification, provide another bond and surety, both of which shall comply with the requirements of Paragraphs 6.01.B and 6.02.

SC-6.02. Add the following new paragraph immediately after Paragraph 6.02.A:

6.02.A.1. Surety and insurance companies from which the bonds and insurance for this Project are purchased shall have an A.M. Best's rating of no less than A- with a Financial Size Category of VIII or higher, in addition to other requirements specified herein.

SC-6.03. Add the following new paragraph immediately following Paragraph 6.03.A.4:

6.03.A.5. The limits of liability for the insurance required by Paragraph 6.03 of the General Conditions shall be as stated in Article 20 of Section Conditions of the Contract.

SC-6.05. Insert the following paragraph after 6.05.A.1:

6.05.A.1.a. In addition to the individuals and entities specified in Paragraph 6.05.A.1, include as insureds, the following:

6.05.A.1.a.1) Jacobs Engineering Group

6.05.A.2.a. In addition to the above listed perils, the property insurance shall include equipment breakdown and damage to electrical apparatus from electrical current.

6.05.A.2.b. be maintained in effect until final payment is made unless otherwise agreed to in writing by Owner, Contractor, and Engineer with 30 days written notice to each other loss payee to whom a certificate of insurance has been issued; and

6.05.A.2.c. Comply with the requirements of Paragraph 6.05.A of the General Conditions.

SC-7.02. Add the following language to the end of Paragraph 7.02.B:

7.02.B.1. Contractor and Subcontractor regular working hours consist of 8 working hours within a 9-hour period between 7:00 a.m. and 6:00 p.m., excluding Sundays and holidays. Overtime work is work in excess of 40 hours per week.

SC-7.02. Add the following new paragraph immediately after Paragraph 7.02.B:

7.02.C. Contractor shall be responsible for the cost of any overtime pay or other expense incurred by the Owner for Engineer's services (including those of the Resident Project Representative, if any), Owner's representative, and construction observation services, occasioned by the performance of Work on Saturday, Sunday, any legal holiday, or as overtime on any regular work day. If Contractor is responsible but does not pay, or if the parties are unable to agree as to the amount owed, then Owner may impose a reasonable set-off against payments due under Article 15.

SC-7.05. Add the following language at the end of Paragraph 7.05.D:

Reimbursement rates for Engineer or their officers, directors, members, partners, employees, agents, and other consultants and subcontractors for evaluation of proposed substitutes shall be on the basis established in Paragraph 15.01.E. of these Supplementary Conditions.

SC-7.06. Add the following language at the end of Paragraph 7.06.A:

Contractor shall perform a minimum of 25 percent of the onsite labor with its own employees.

7.08. Add the following new paragraph(s) immediately after Paragraph 7.08.A:

7.08.B. Owner will obtain and pay for the following construction permits and licenses:

7.08.B.1. Georgia EPD 7.08.B.2. Land Disturbance Permit. The project area is less than one acre; the Land Disturbance Permit is not required by either EPD or Fayette County.

SC-7.10. Add the following new paragraph(s) immediately after Paragraph 7.10.C:

7.10.D. While not intended to be inclusive of all Laws or Regulations for which Contractor may be responsible under Paragraph 7.10, the following Laws or Regulations are included as mandated by statute or for the convenience of Contractor:

7.10.D.1. Security and Immigration Act: Contractor and its Subcontractors shall register and comply with OCGA 13-10-90 et. seq. and Georgia Department of Labor Chapter 300-10-1.

SC-10.03. Add the following new paragraphs immediately after Paragraph 10.03.A:

10.03.B. Resident Project Representative (RPR) will be furnished by Engineer. The responsibilities, authority, and limitations of the RPR are limited to those of Engineer in accordance with Paragraph 10.08 and as set forth elsewhere in the Contract Documents and are further limited and described below.

10.03.C. Responsibilities and Authority:

10.03.C.1. Schedules: Review and monitor Progress Schedule, Schedule of Submittals, and Schedule of Values prepared by Contractor and consult with Engineer concerning acceptability.

10.03.C.2. Conferences and Meetings: Conduct or attend meetings with Contractor, such as preconstruction conferences, progress meetings, Work conferences and other Project related meetings.

10.03.C.3. Liaison: (i) Serve as Engineer's liaison with Contractor, working principally through Contractor's authorized representative, and assist in understanding the intent of the Contract Documents; (ii) assist Engineer in serving as Owner's liaison with Contractor when Contractor's operations affect Owner's onsite operations; (iii) assist in obtaining from Owner additional details or information when required for proper execution of the Work.

10.03.C.4. Interpretation of Contract Documents: Inform Engineer when clarifications and interpretations of the Contract Documents are needed and transmit to Contractor clarifications and interpretations as issued by Engineer.

10.03.C.5. Submittals: Receive submittals that are furnished at the Site by Contractor, and notify Engineer of availability for examination. Advise Engineer and Contractor of the commencement of any Work or arrival of materials and equipment at Site, when recognized, requiring a Shop Drawing or Sample if the submittal has not been approved by Engineer.

10.03.C.6. Modifications: Consider and evaluate Contractor's suggestions for modifications in Drawings or Specifications and provide recommendations to Engineer; transmit to Contractor, in writing decisions as issued by Engineer.

10.03.C.7. Review of Work and Rejection of Defective Work: (i) Conduct onsite observations of the Work in progress to assist Engineer in determining if the Work is, in general, proceeding in accordance with the Contract Documents; (ii) inform Engineer and Contractor whenever RPR believes that any Work is defective; (iii) advise Engineer whenever RPR believes that any Work will not produce a completed Project that conforms generally to the Contract Documents or will imperil the integrity of the design concept of the completed Project as a functioning whole as indicated in the Contract Documents, or has been damaged or does not meet the requirements of any inspection test, or approval required to be made; and advise Engineer of that part of the Work in progress that RPR believes should be corrected or rejected or uncovered for observation, or requires special testing, inspection, or approval.

10.03.C.8. Inspections, Tests, and System Startups: (i) Verify tests, equipment and systems startups and operating and maintenance training are conducted in the presence of appropriate personnel, and that Contractor maintains adequate records thereof; (ii) observe, record, and report to Engineer appropriate details relative to the test procedures and system startups; and (iii) accompany visiting inspectors representing public or other agencies having jurisdiction over the Project, record the results of these inspections, and report to Engineer.

10.03.C.9. Records: (i) Maintain records for use in preparing Project documentation; (ii) keep a diary or log book recording pertinent Site conditions, activities, decisions and events; (iii) record names, addresses, fax numbers, e-mail addresses, web site locations, and telephone numbers of Contractors, Subcontractors, and major Suppliers of materials and equipment.

10.03.C.10. Reports: (i) Furnish Engineer periodic reports of progress of the Work and of Contractor's compliance with the Progress Schedule and Schedule of Submittals; (ii) immediately notify Engineer of the occurrence of Site accidents, emergencies, acts of God endangering the Work, damage to property by fire or other causes, or the discovery of any Hazardous Environmental Condition; and (iii) assist Engineer in drafting proposed

Change Orders, Work Change Directives, and Field Orders; obtain backup material from Contractor as appropriate.

10.03.C.11. Payment Requests: Review Applications for Payment with Contractor for compliance with the established procedure for their submission and forward with recommendations to Engineer, noting particularly the relationship of the payment requested to the Schedule of Values, Work completed, and materials and equipment delivered at the Site but not incorporated in the Work.

10.03.C.12. Certificates, Operation and Maintenance Manuals: During the course of the Work, verify materials and equipment certificates and operation and maintenance manuals and other data required by Specifications to be assembled and furnished by Contractor are applicable to the items actually installed and in accordance with the Contract Documents, and have these documents been delivered to Engineer for review and forwarding to Owner prior to payment for that part of the Work.

10.03.C.13. Completion: (i) Participate in a Substantial Completion inspection; assist in determination of Substantial Completion and the preparation of lists of items to be completed or corrected; (ii) Participate in a final inspection in the company of Engineer, Owner, and Contractor and prepare a final list of items to be completed and deficiencies to be remedied; and (iii) observe whether items on final list have been completed or corrected, and make recommendations to Engineer concerning acceptance.

10.03.D. Limitations of Authority: Resident Project Representative will not:

10.03.D.1. have authority to authorize a deviation from Contract Documents or substitution of materials or equipment, unless authorized by Engineer; or

10.03.D.2. exceed the limitations of Engineer's authority as set forth in Contract Documents; or

10.03.D.3. undertake any of the responsibilities of Contractor, Subcontractors, Suppliers, or Contractor's authorized representative; or

10.03.D.4. advise on, issue directions relative to, or assume control over an aspect of the means, methods, techniques, sequences, or procedures of Contractor's work unless such advice or directions are specifically required by the Contract Documents; or

10.03.D.5. advise on, issue directions regarding, or assume control over safety practices, precautions, and programs in connection with the activities or operations of Owner or Contractor; or

10.03.D.6. participate in specialized field or laboratory tests or inspections conducted offsite by others, except as specifically authorized by Engineer; or

10.03.D.7. accept Shop Drawings or Samples from anyone other than Contractor; or

10.03.D.8. authorize Owner to occupy the Project in whole or in part.

SC-10.08. Add the following new paragraph immediately after Paragraph 10.08.E:

10.08.F. Contractors, Subcontractors, Suppliers, and others on the Project, or their sureties, shall maintain no direct action against Engineer, its officers, employees, affiliated corporations, and subcontractors, for any Claim arising out of, in connection with, or resulting from the engineering services performed. Only the Owner will be the beneficiary of any undertaking by Engineer.

SC-11.04. Add the following new paragraph immediately after Paragraph 11.04.C:

11.04.D. In the event Contractor submits request for additional compensation as a result of a change or differing Site conditions, or as a result of delays, acceleration, or loss of productivity, Owner reserves right, upon written request, to audit and inspect Contractor's books and records relating to the Project. Upon written request for an audit, Contractor shall make its books and records available within 14 days of request. Owner shall specifically designate identity of auditor. As part of audit, Contractor shall make available its books and records relating to the Project, including but not limited to Bidding Documents, cost reports, payroll records, material invoices, subcontracts, purchase orders, daily timesheets, and daily diaries. Audit shall be limited to those cost items which are sought by Contractor in a change order or claim submission to Owner.

SC-13.01. Delete Paragraph 13.01.B.5.c in its entirety and insert the following in its place:

13.01.B.5.c. Construction Equipment and Machinery:

13.01.B.5.c.(1) Rentals of construction equipment and machinery, and the parts thereof in accordance with rental agreements approved by Owner with the advice of Engineer, and the costs of transportation, loading, unloading, assembly, dismantling, and removal thereof. Such costs shall be in accordance with the terms of said rental agreements. The rental of any such equipment, machinery, or parts shall cease when the use thereof is no longer necessary for the Work.

13.01.B.5.c.(2) Costs for equipment and machinery owned by Contractor will be paid at a rate shown for such equipment in the Rental Rate Blue Book published by Equipment Watch. An hourly rate will be computed by dividing the monthly rates by 176. These computed rates will include all operating costs. Costs will include the time the equipment or machinery is in use on the changed Work and the costs of transportation, loading, unloading, assembly, dismantling, and removal when

directly attributable to the changed Work. The cost of such equipment or machinery, or parts thereof, shall cease to accrue when the use thereof is no longer necessary for the changed Work. Equipment or machinery with a value of less than \$1,000 will be considered small tools.

SC-14.02. Delete Paragraph 14.02.B in its entirety and insert the following in its place:

14.02.B. Contractor shall retain an independent testing laboratory or testing agency, to be selected by the Owner, and shall be responsible for arranging and shall pay for specified tests, inspections, and approvals, including tests, inspections, and approvals to be paid for on a cash allowance basis, required for Owner's and Engineer's acceptance of the Work at the Site except:

14.02.B.1. costs incurred in connection with tests or inspections pursuant to Paragraph 14.02.C shall be paid for as provided in said paragraph; and

14.02.B.2. as otherwise specifically provided in the Contract Documents.

SC-14.02. Add the following language at the end of Paragraph 14.02.D:

Tests required by Contract Documents to be performed by Contractor that require test certificates be submitted to Owner or Engineer for acceptance shall be made by an independent testing laboratory or agency licensed or certified in accordance with Laws and Regulations and applicable state and local statutes. In the event state license or certification is not required, testing laboratories or agencies shall meet the following applicable requirements:

14.02.D.6. Basic requirements of ASTM E329, "Standard Specification for Agencies Engaged in Construction Inspection, Testing, or Special Inspection" as applicable.

14.02.D.7. Calibrate testing equipment at reasonable intervals by devices of accuracy, traceable to the National Institute of Standards and Technology or accepted values of natural physical constants.

SC-15.01. Delete Paragraph 15.01.D.1 in its entirety and insert the following in its place:

15.01.D.1. Thirty days after presentation of the Application for Payment to Owner with Engineer's recommendation, the amount recommended will (subject to the provisions of Paragraph 15.01.E.) become due and when due will be paid by Owner to Contractor.

SC 15.03.B. Add the following new subparagraph to Paragraph 15.03.B:

SC 15.03.B.1. If some or all of the Work has been determined not to be at a point of Substantial Completion and will require re-inspection or re-testing by Engineer, the

cost of such re-inspection or re-testing, including the cost of time, travel and living expenses, shall be paid by Contractor to Owner. If Contractor does not pay, or the parties are unable to agree as to the amount owed, then Owner may impose a reasonable set-off against payments due under Article 15.

SC-17.02. Add the following new paragraph immediately after Paragraph 17.01:

SC-17.02 Attorneys' Fees: For any matter subject to final resolution under this Article, the prevailing party shall be entitled to an award of its attorneys' fees incurred in the final resolution proceedings, in an equitable amount to be determined in the discretion of the court, arbitrator, arbitration panel, or other arbiter of the matter subject to final resolution, taking into account the parties' initial demand or defense positions in comparison with the final result.

END OF SECTION

PART 3

SPECIFICATIONS

**SECTION 01 11 00
SUMMARY OF WORK**

PART 1 GENERAL

1.01 WORK COVERED BY CONTRACT DOCUMENTS

- A. The completed Work will provide Owner with a new chlorine dioxide generation system and includes the new chlorine dioxide generator package system and associated bulk chemical storage and containment.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01 26 00
CONTRACT MODIFICATION PROCEDURES

PART 1 GENERAL

1.01 PROPOSAL REQUESTS

- A. Owner may, in anticipation of ordering an addition, deletion, or revision to the Work, request Contractor to prepare a detailed proposal of cost and times to perform contemplated change.
- B. Proposal request will include reference number for tracking purposes and detailed description of and reason for proposed change, and such additional information as appropriate and as may be required for Contractor to accurately estimate cost and time impact on Project.
- C. Proposal request is for information only; Contractor is neither authorized to execute proposed change nor to stop Work in progress as result of such request.
- D. Contractor's written proposal shall be transmitted to Engineer promptly, but not later than 14 days after Contractor's receipt of Owner's written request. Proposal shall remain firm for a maximum period of 45 days after receipt by Engineer.
- E. Owner's request for proposal or Contractor's failure to submit such proposal within the required time period will not justify a Claim for an adjustment in Contract Price or Contract Times (or Milestones).

1.02 CLAIMS

- A. Include, at a minimum:
 - 1. Specific references including (i) Drawing numbers, (ii) Specification section and article/paragraph number, and (iii) Submittal type, Submittal number, date reviewed, Engineer's comment, as applicable, with appropriate attachments.
 - 2. Stipulated facts and pertinent documents, including photographs and statements.
 - 3. Interpretations relied upon.
 - 4. Description of (i) nature and extent of Claim, (ii) who or what caused the situation, (iii) impact to the Work and work of others, and (iv) discussion of claimant's justification for requesting a change to price or times or both.
 - 5. Estimated adjustment in price claimant believes it is entitled to with full documentation and justification.

6. Requested Change in Contract Times: Include at least (i) Progress Schedule documentation showing logic diagram for request, (ii) documentation that float times available for Work have been used, and (iii) revised activity logic with durations including sub-network logic revisions, duration changes, and other interrelated schedule impacts, as appropriate.
7. Documentation as may be necessary as set forth below for Work Change Directive, and as Engineer may otherwise require.

1.03 WORK CHANGE DIRECTIVES

A. Procedures:

1. Engineer will:
 - a. Initiate, including a description of the Work involved and any attachments.
 - b. Affix signature, demonstrating Engineer's recommendation.
 - c. Transmit three copies to Owner for authorization.
2. Owner will:
 - a. Affix signature, demonstrating approval of the changes involved.
 - b. Return two copies to Engineer, who will retain one copy and forward one copy to Contractor.
3. Upon completion of Work covered by the Work Change Directive or when final Contract Times and Contract Price are determined, Contractor shall submit documentation for inclusion in a Change Order.
4. Contractor's documentation shall include but not be limited to:
 - a. Appropriately detailed records of Work performed to enable determination of value of the Work.
 - b. Full information required to substantiate resulting change in Contract Times and Contract Price for Work. On request of Engineer, provide additional data necessary to support documentation.
 - c. Support data for Work performed on a unit price or Cost of the Work basis with additional information such as:
 - 1) Dates Work was performed, and by whom.
 - 2) Time records, wage rates paid, and equipment rental rates.
 - 3) Invoices and receipts for materials, equipment, and subcontracts, all similarly documented.

- B. Effective Date of Work Change Directive: Date of signature by Owner, unless otherwise indicated thereon.

1.04 CHANGE ORDERS

A. Procedure:

1. Engineer will prepare four copies of proposed Change Order and transmit such with Engineer's written recommendation and request to Contractor for signature.
2. Contractor shall, upon receipt, either: (i) promptly sign copies, retaining one for its file, and return remaining three copies to Engineer for Owner's signature, or (ii) return unsigned three copies with written justification for not executing Change Order.
3. Engineer will, upon receipt of Contractor signed copies, promptly forward Engineer's written recommendation and partially executed three copies for Owner's signature, or if Contractor fails to execute the Change Order, Engineer will promptly so notify Owner and transmit Contractor's justification to Owner.
4. Upon receipt of Contractor-executed Change Order, Owner will promptly either:
 - a. Execute Change Order, retaining one copy for its file and returning two copies to Engineer; or
 - b. Return to Engineer unsigned copies with written justification for not executing Change Order.
5. Upon receipt of Owner-executed Change Order, Engineer will transmit one copy to Contractor and retain one copy, or if Owner fails to execute the Change Order, Engineer will promptly so notify Contractor and transmit Owner's justification to Contractor.
6. Upon receipt of Owner-executed Change Order, Contractor shall:
 - a. Perform Work covered by Change Order.
 - b. Revise Schedule of Values to adjust Contract Price and submit with next Application for Payment.
 - c. Revise Progress Schedule to reflect changes in Contract Times, if any, and to adjust times for other items of Work affected by change.
 - d. Enter changes in Project record documents after completion of change related Work.

B. In signing a Change Order, Owner and Contractor acknowledge and agree that:

1. Stipulated compensation (Contract Price or Contract Times, or both) set forth includes payment for (i) the Cost of the Work covered by the Change Order, (ii) Contractor's fee for overhead and profit, (iii) interruption of Progress Schedule, (iv) delay and impact, including cumulative impact, on other Work under the Contract Documents, and (v) extended overheads.

2. Change Order constitutes full mutual accord and satisfaction for the change to the Work.
3. Unless otherwise stated in the Change Order, all requirements of the original Contract Documents apply to the Work covered by the Change Order.

1.05 COST OF THE WORK

- A. In determining the supplemental costs allowed in Paragraph 13.01.B.5 of the General Conditions for rental equipment and machinery, the following will apply.
- B. Rental of construction equipment and machinery and the parts thereof having a replacement value in excess of \$1,000, whether owned by Contractor or rented or leased from others, shall meet the following requirements:
 1. Full rental costs for leased equipment shall not exceed rates listed in the Rental Rate Blue Book published by Equipment Watch, as adjusted to the regional area of the Project. Owned equipment costs shall not exceed the single shift rates established in the Cost Reference Guide (CRG) published by Equipment Watch. The most recent published edition in effect at commencement of actual equipment use shall be used.
 2. Rates shall apply to equipment in good working condition. Equipment not in good condition, or larger than required, may be rejected by Engineer or accepted at reduced rates.
 3. Leased Equipment: For equipment leased or rented in arm's length transactions from outside vendors, maximum rates shall be determined by the following actual usage/Payment Category:
 - a. Less than 8 hours: Hourly rate.
 - b. 8 or more hours but less than 7 days: Daily rate.
 - c. 7 or more days but less than 30 days: Weekly rate.
 - d. 30 days or more: Monthly rate.
 4. Arm's length rental and lease transactions are those in which the firm involved in the rental or lease of equipment is not associated with, owned by, have common management, directorship, facilities and/or stockholders with the firm renting the equipment.
 5. Financial arrangements associated with rental and lease transactions that provide Contractor remuneration or discounts not visible to the Owner must be disclosed and integrated with charged rates.

6. Leased Equipment in Use: Actual equipment use time documented by Engineer shall be the basis that equipment was on and utilized at the Project Site. In addition to the leasing rate above, equipment operational costs shall be paid at the estimated hourly operating cost rate set forth in the Rental Rate Blue Book if not already included in the lease rate. Hours of operation shall be based upon actual equipment usage to the nearest quarter hour, as recorded by Engineer.
7. Leased Equipment, When Idle (Standby): Idle or standby equipment is equipment onsite or in transit to and from the Work Site and necessary to perform the Work under the modification, but not in actual use. Idle equipment time, as documented by Engineer, shall be paid at the leasing rate determined above, excluding operational costs.
8. Owned and Other Equipment in Use: Equipment rates for owned equipment or equipment provided in other than arm's length transaction shall not exceed the single shift total hourly costs rate developed in accordance with the CRG and as modified herein for multiple shifts. This total hourly rate will be paid for each hour the equipment actually performs work. Hours of operation shall be based upon actual equipment usage as recorded by Engineer. This rate shall represent payment in full for Contractor's direct costs.
9. Owned and Other Equipment, When Idle (Standby): Equipment necessary to be onsite to perform the Work on single shift operations, but not utilized, shall be paid for at the ownership hourly expense rate developed in accordance with the CRG, provided its presence and necessity onsite has been documented by Engineer. Payment for idle time of portions of a normal workday, in conjunction with original contract Work, will not be allowed. In no event shall idle time claimed in a day for a particular piece of equipment exceed the normal Work or shift schedule established for the Project. It is agreed that this rate shall represent payment in full for Contractor's direct costs. When Engineer determines that the equipment is not needed to continuously remain at the Work Site, payment will be limited to actual hours in use.
10. Owned and Other Equipment, Multiple Shifts: For multiple shift operations, the CRG single shift total hourly costs rate shall apply to the operating equipment during the first shift. For subsequent shifts, up to two in a 24-hour day, operating rate shall be the sum of the total hourly CRG operating cost and 60 percent of the CRG ownership and overhaul expense. Payment for idle or standby time for second and third shifts shall be 20 percent of the CRG ownership and overhaul expense.
11. When necessary to obtain owned equipment from sources beyond the Project limits, the actual cost to transfer equipment to the Site and return it to its original location will be allowed as an additional item of expense. Move-in and move-out allowances will not be made for equipment brought to the Project if the equipment is also used on original Contract or related Work.

12. If the move-out destination is not to the original location, payment for move-out will not exceed payment for move-in.
13. If move is made by common carrier, the allowance will be the amount paid for the freight. If equipment is hauled with Contractor's own forces, rental will be allowed for the hauling unit plus the hauling unit operator's wage. If equipment is transferred under its own power, the rental will be 75 percent of the appropriate total hourly costs for the equipment, without attachments, plus the equipment operator's wage.
14. Charges for time utilized in servicing equipment to ready it for use prior to moving and similar charges will not be allowed.
15. When a breakdown occurs on any piece of owned equipment, payment shall cease for that equipment and any other owned equipment idled by the breakdown.
16. If any part of the Work is shut down by Owner, standby time will be paid during nonoperating hours if diversion of equipment to other Work is not practicable. Engineer reserves the right to cease standby time payment when an extended shutdown is anticipated.
17. If a rate has not been established in the CRG for owned equipment, Contractor may:
 - a. If approved by Engineer, use the rate of the most similar model found, considering such characteristics as manufacturer, capacity, horsepower, age, and fuel type, or
 - b. Request Equipment Watch to furnish a written response for a rate on the equipment, which shall be presented to Engineer for approval; or
 - c. Request Engineer to establish a rate.

1.06 FIELD ORDER

- A. Engineer will issue Field Orders, with three copies to Contractor.
- B. Effective date of the Field Order shall be the date of signature by Engineer, unless otherwise indicated thereon.
- C. Contractor shall acknowledge receipt by signing and returning one copy to Engineer.
- D. Field Orders will be incorporated into subsequent Change Orders, as a no-cost change to the Contract.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

**SECTION 01 29 00
PAYMENT PROCEDURES**

PART 1 GENERAL

1.01 SUBMITTALS

A. Informational Submittals:

1. Schedule of Values: Submit on Contractor's standard form.
2. Application for Payment.
3. Final Application for Payment.

1.02 CASH ALLOWANCES

- A. Cash allowances will be administered in accordance with Paragraph 13.02 of General Conditions.**
- B. Submit, with application for payment, invoice showing date of purchase, from whom the purchase was made, the date of delivery of the product or service, and the price, including delivery to the Site and applicable taxes.**

1.03 SCHEDULE OF VALUES

- A. Upon request of Engineer, provide documentation to support the accuracy of the Schedule of Values.**
- B. Lump Sum Work:**
1. Reflect specified cash allowances, as applicable.
 2. List bonds and insurance premiums, mobilization, demobilization, preliminary and detailed progress schedule preparation, equipment testing, facility startup, and contract closeout separately.
 3. Break down by Division 02 through 49.
- C. An unbalanced or front-end loaded schedule will not be acceptable.**
- D. Summation of the complete Schedule of Values representing all the Work shall equal the Contract Price.**

1.04 APPLICATION FOR PAYMENT

- A. Transmittal Summary Form: Attach one Summary Form with each detailed Application for Payment for each schedule and include Request for Payment of Materials and Equipment on Hand as applicable. Execute certification by authorized officer of Contractor.**

- B. Use detailed Application for Payment Form provided by Engineer.
- C. Include accepted Schedule of Values.
- D. Include separate line item for each Change Order and Work Change Directive executed prior to date of submission. Provide further breakdown of such as requested by Engineer.
- E. Preparation:
 - 1. Round values to nearest dollar.
 - 2. Submit Application for Payment, including a Transmittal Summary Form, a listing of materials on hand, and such supporting data as may be requested by Engineer.

1.05 PAYMENT

- A. Payment for all Lump Sum Work shown or specified in Contract Documents is included in the Contract Price. Payment will be based on a percentage complete basis for each line item of the accepted Schedule of Values.

1.06 NONPAYMENT FOR REJECTED OR UNUSED PRODUCTS

- A. Payment will not be made for following:
 - 1. Loading, hauling, and disposing of rejected material.
 - 2. Quantities of material wasted or disposed of in manner not called for under Contract Documents.
 - 3. Rejected loads of material, including material rejected after it has been placed by reason of failure of Contractor to conform to provisions of Contract Documents.
 - 4. Material not unloaded from transporting vehicle.
 - 5. Defective Work not accepted by Owner.
 - 6. Material remaining on hand after completion of Work.

1.07 PARTIAL PAYMENT FOR STORED MATERIALS AND EQUIPMENT

- A. Partial Payment: No partial payments will be made for materials and equipment delivered or stored unless Shop Drawings and preliminary operation and maintenance data is acceptable to Engineer.
- B. Final Payment: Will be made only for products incorporated in Work; remaining products, for which partial payments have been made, shall revert to Contractor unless otherwise agreed, and partial payments made for those items will be deducted from final payment.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01 31 13
PROJECT COORDINATION

PART 1 GENERAL

1.01 SUBMITTALS

A. Informational:

1. Photographs: In accordance with Article Construction Photographs.

1.02 UTILITY NOTIFICATION AND COORDINATION

- A. Coordinate the Work with various utilities within Project limits. Notify applicable utilities prior to commencing Work, if damage occurs, or if conflicts or emergencies arise during the Work.**

1. Water Department: Owner.

1.03 WORK SEQUENCING/CONSTRAINTS

- A. Include the following work sequences in the Progress Schedule:**

1. The existing chlorine dioxide system must remain operational until the new chlorine dioxide generation system is installed and made operational. The Contractor shall relocate the existing sodium chlorite drums and containment tubs to the area outside the chlorine dioxide room and the existing HVAC duct shall be modified as indicated in the Drawings prior to beginning installation of the new generation equipment. One of the two existing chlorine dioxide feed pumps (the Accuflow pump) and its associated electrical components may be removed from service to facilitate installation of the new equipment and piping. Coordinate removal of the pump with plant staff; the pump and controller are to be delivered to the Owner as salvaged equipment. It will be necessary for WTP operators to periodically transfer sodium chlorite to the solutioning tank in the chlorine dioxide room while construction is underway. The Contractor shall coordinate work with the plant staff to ensure safe operating conditions inside the space. The new chlorine dioxide generation system must be operational before the existing system is demolished. Discharge of chlorine dioxide from the new generator cabinet shall be connected to existing chlorine dioxide piping as shown on the Drawings. Both the existing and new generators shall be connected to the existing feed piping to the injection point until all functional and performance testing has been completed for the new generation system. Piping to and from the original chlorine dioxide generator and peristaltic feed pump shall be removed only after the new

chlorine dioxide generation system is in service. The peristaltic feed pump and controller used for feeding chlorine dioxide from the original generator shall be turned over to the Owner as salvage equipment.

1.04 FACILITY OPERATIONS

- A. Continuous operation of Owner's facilities is of critical importance. Schedule and conduct activities to enable existing facilities to operate continuously, unless otherwise specified.
- B. Perform Work continuously during critical connections and changeovers, and as required to prevent interruption of Owner's operations.
- C. When necessary, plan, design, and provide various temporary services, utilities, connections, temporary piping and heating, access, and similar items to maintain continuous operations of Owner's facility.
- D. Do not close lines, open or close valves, or take other action which would affect the operation of existing systems, except as specifically required by the Contract Documents and after authorization by Owner and Engineer. Such authorization will be considered within 48 hours after receipt of Contractor's written request.
- E. Process or Facility Shutdown:
 - 1. Connecting the chlorine dioxide discharge piping from the new generator to the existing feed piping to the injection point will require a short plant shut-down, as will disconnecting the existing chlorine dioxide generation from the injection feed piping. Contractor shall coordinate with the Owner for both occurrences, providing 5 days advance notice to Owner and Engineer.
 - 2. Power outages will be considered upon 48 hours written request to Owner and Engineer. Describe the reason, anticipated length of time, and areas affected by the outage. Provide temporary provisions for continuous power supply to critical facility components.
- F. Do not proceed with Work affecting a facility's operation without obtaining Owner's and Engineer's advance approval of the need for and duration of such Work.
- G. Relocation of Existing Facilities:
 - 1. During construction, it is expected that minor relocations of Work will be necessary.
 - 2. Provide complete relocation of existing structures and Underground Facilities, including piping, utilities, equipment, structures, electrical conduit wiring, electrical duct bank, and other necessary items.

3. Use only new materials for relocated facility. Match materials of existing facility, unless otherwise shown or specified.
4. Perform relocations to minimize downtime of existing facilities.
5. Install new portions of existing facilities in their relocated position prior to removal of existing facilities, unless otherwise accepted by Engineer.

1.05 ADJACENT FACILITIES AND PROPERTIES

A. Examination:

1. After Effective Date of the Agreement and before Work at Site is started, Contractor, Engineer, and Owner shall make a thorough examination of pre-existing conditions including existing buildings, structures, and other improvements in vicinity of Work, as applicable, which could be damaged by construction operations.
2. Periodic reexamination shall be jointly performed to include, but not limited to, cracks in structures, settlement, leakage, and similar conditions.

B. Documentation:

1. Record and submit documentation of observations made on examination inspections in accordance with Article Construction Photographs.

1.06 CONSTRUCTION PHOTOGRAPHS

A. General:

1. Photographically document all phases of the Project including preconstruction, construction progress, and post-construction.
2. Engineer shall have right to select subject matter and vantage point from which photographs are to be taken.
3. Digital Images: No post-session electronic editing of images is allowed. Stored image shall be actual image as captured without cropping or other edits.

B. Preconstruction and Post-Construction:

1. After Effective Date of the Agreement and before Work at Site is started, and again upon issuance of Substantial Completion, take a minimum of 12 photographs of Site.
2. Format: Digital, minimum resolution of 1680 by 2240 pixels and 24-bit, millions of color.

C. Construction Progress Photos:

1. Photographically demonstrate progress of construction, showing every aspect of Site and adjacent properties as well as interior and exterior of new or impacted structures.
2. Weekly: Take 10 photographs using digital, minimum resolution of 1680 by 2240 pixels and 24-bit, millions of color. Submit with Payment Application.

1.07 REFERENCE POINTS AND SURVEYS

A. Contractor's Responsibilities:

1. Provide survey and layout required to layout the Work.
2. Check and establish exact location of existing facilities prior to construction of new facilities and any connections thereto.
3. In event of discrepancy in data or staking provided by Owner, request clarification before proceeding with Work.
4. Maintain complete accurate log of survey work as it progresses as a Record Document.
5. On request of Engineer, submit documentation.
6. Provide competent employee(s), tools, stakes, and other equipment and materials as Engineer may require to:
 - a. Establish control points and lines.
 - b. Check layout and survey.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 CUTTING, FITTING, AND PATCHING

- A. Cut, fit, adjust, or patch Work and work of others, including excavation and backfill as required, to make Work complete.
- B. Obtain prior written authorization of Engineer before commencing Work to cut or otherwise alter:
 1. Structural or reinforcing steel, structural column or beam, elevated slab, trusses, or other structural member.
 2. Weather-resistant or moisture-resistant elements.
 3. Efficiency, maintenance, or safety of element.
 4. Work of others.

- C. Refinish surfaces to provide an even finish.
 - 1. Refinish continuous surfaces to nearest intersection.
 - 2. Refinish entire assemblies.
 - 3. Finish restored surfaces to such planes, shapes, and textures that no transition between existing work and the Work is evident in finished surfaces.
- D. Restore existing work, Underground Facilities, and surfaces that are to remain in completed Work including concrete-embedded piping, conduit, and other utilities as specified and as shown on Drawings.
- E. Make restorations with new materials and appropriate methods as specified for new Work of similar nature; if not specified, use recommended practice of manufacturer or appropriate trade association.
- F. Fit Work airtight to pipes, sleeves, ducts, conduit, and other penetrations through surfaces and fill voids.
- G. Remove specimens of installed Work for testing when requested by Engineer.

END OF SECTION

**SECTION 01 31 19
PROJECT MEETINGS**

PART 1 GENERAL

1.01 GENERAL

- A. Engineer will schedule physical arrangements for meetings throughout progress of the Work, prepare meeting agenda with regular participant input and distribute with written notice of each meeting, preside at meetings, record minutes to include significant proceedings and decisions, and reproduce and distribute copies of minutes within 5 days after each meeting to participants and parties affected by meeting decisions.

1.02 PRECONSTRUCTION CONFERENCE

- A. Contractor shall be prepared to discuss the following subjects, as a minimum:

1. Required schedules.
2. Status of Bonds and insurance.
3. Sequencing of critical path work items.
4. Progress payment procedures.
5. Project changes and clarification procedures.
6. Use of Site, access, office and storage areas, security and temporary facilities.
7. Major product delivery and priorities.
8. Contractor's safety plan and representative.

- B. Attendees will include:

1. Owner's representatives.
2. Contractor's office representative.
3. Contractor's resident superintendent.
4. Contractor's quality control representative.
5. Subcontractors' representatives whom Contractor may desire or Engineer may request to attend.
6. Engineer's representatives.
7. Others as appropriate.

1.03 PRELIMINARY SCHEDULES REVIEW MEETING

- A. As set forth in General Conditions and Section 01 32 00, Construction Progress Documentation.

1.04 PROGRESS MEETINGS

- A. Engineer will schedule regular progress meetings at Site, conducted monthly or as necessary to review the Work progress, Progress Schedule, Schedule of Submittals, Application for Payment, contract modifications, and other matters needing discussion and resolution.
- B. Attendees will include:
 - 1. Owner's representative(s), as appropriate.
 - 2. Contractor, Subcontractors, and Suppliers, as appropriate.
 - 3. Engineer's representative(s).
 - 4. Others as appropriate.

1.05 PREINSTALLATION MEETINGS

- A. When required in individual Specification sections, convene at Site prior to commencing the Work of that section.
- B. Require attendance of entities directly affecting, or affected by, the Work of that section.
- C. Notify Engineer 4 days in advance of meeting date.
- D. Provide suggested agenda to Engineer to include reviewing conditions of installation, preparation and installation or application procedures, and coordination with related Work and work of others.

1.06 FACILITY STARTUP MEETINGS

- A. Schedule and attend a minimum of two facility startup meetings. The first of such meetings shall be held prior to submitting Facility Startup Plan, as specified in Section 01 91 14, Equipment Testing and Facility Startup, and shall include preliminary discussions regarding such plan.
- B. Agenda items shall include, but not be limited to, content of Facility Startup Plan, coordination needed between various parties in attendance, and potential problems associated with startup.
- C. Attendees will include:
 - 1. Contractor.
 - 2. Contractor's designated quality control representative.
 - 3. Subcontractors and equipment manufacturer's representatives whom Contractor deems to be directly involved in facility startup.

4. Engineer's representatives.
5. Owner's operations personnel.
6. Others as required by Contract Documents or as deemed necessary by Contractor.

1.07 OTHER MEETINGS

- A. In accordance with Contract Documents and as may be required by Owner and Engineer.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01 32 00
CONSTRUCTION PROGRESS DOCUMENTATION

PART 1 GENERAL

1.01 SUBMITTALS

A. Informational Submittals:

1. Preliminary Progress Schedule: Submit within time specified in Paragraph 2.03 of the General Conditions.
2. Detailed Progress Schedule:
 - a. Submit initial Detailed Progress Schedule within 60 days after Effective Date of the Agreement.
 - b. Submit an Updated Progress Schedule at each update, in accordance with Article Detailed Progress Schedule.
3. Submit with Each Progress Schedule Submission:
 - a. Contractor's certification that Progress Schedule submission is actual schedule being used for execution of the Work.
 - b. Progress Schedule: One legible copy.
 - c. Narrative Progress Report: Same number of copies as specified for Progress Schedule.
4. Prior to final payment, submit a final Updated Progress Schedule.

1.02 PRELIMINARY PROGRESS SCHEDULE

- A. In addition to basic requirements outlined in General Conditions, show a detailed schedule, beginning with Notice to Proceed, for minimum duration of 90 days, and a summary of balance of Project through Final Completion.**
- B. Show activities including, but not limited to the following:**
1. Notice to Proceed.
 2. Permits.
 3. Submittals, with review time.
 4. Early procurement activities for long lead equipment and materials.
 5. Initial Site work.
 6. Earthwork.
 7. Specified Work sequences and construction constraints.
 8. Contract Completion Date.
 9. Major structural, mechanical, equipment, electrical, architectural, and instrumentation and control Work.
 10. System startup summary.
 11. Project close-out summary.
 12. Demobilization summary.

- C. Update Preliminary Progress Schedule monthly as part of progress payment process. Failure to do so may result in the Owner withholding all or part of the monthly progress payment until the Preliminary Progress Schedule is updated in a manner acceptable to Engineer.
- D. Format: In accordance with Article Progress Schedule—Bar Chart.

1.03 DETAILED PROGRESS SCHEDULE

- A. In addition to requirements of General Conditions, submit Detailed Progress Schedule beginning with Notice to Proceed and continuing through Final Completion.
- B. Show the duration and sequences of activities required for complete performance of the Work reflecting means and methods chosen by Contractor.
- C. When accepted by Engineer, Detailed Progress Schedule will replace Preliminary Progress Schedule and become Baseline Schedule. Subsequent revisions will be considered as Updated Progress Schedules.
- D. Format: In accordance with Article Progress Schedule—Bar Chart.
- E. Update as necessary to reflect actual progress and occurrences to date, including weather delays.

1.04 PROGRESS SCHEDULE—BAR CHART

- A. General: Comprehensive bar chart schedule, generally as outlined in Associated General Contractors of America (AGC) 580, “Construction Project Planning and Scheduling Guidelines.” If a conflict occurs between the AGC publication and this specification, this specification shall govern.
- B. Format:
 - 1. Unless otherwise approved, white paper, 11-inch by 17-inch sheet size.
 - 2. Title Block: Show name of Project and Owner, date submitted, revision or update number, and name of scheduler.
 - 3. Identify horizontally, across the top of the schedule, the time frame by year, month, and day.
 - 4. Identify each activity with a unique number and a brief description of the Work associated with that activity.
 - 5. Legend: Describe standard and special symbols used.

- C. Contents: Identify, in chronological order, those activities reasonably required to complete the Work, including as applicable, but not limited to:
1. Obtaining permits, submittals for early product procurement, and long lead time items.
 2. Mobilization and other preliminary activities.
 3. Initial Site work.
 4. Specified Work sequences and constraints, including Substantial Completion date(s).
 5. Subcontract Work.
 6. Major equipment design, fabrication, factory testing, and delivery dates.
 7. Sitework.
 8. Concrete Work.
 9. Structural steel Work.
 10. Equipment Work.
 11. Electrical Work.
 12. Instrumentation and control Work.
 13. Equipment and system startup and test activities.
 14. Project closeout and cleanup.
 15. Demobilization.

1.05 PROGRESS OF THE WORK

- A. Updated Progress Schedule shall reflect:
1. Progress of Work to within 5 working days prior to submission.
 2. Approved changes in Work scope and activities modified since submission.
 3. Delays in Submittals or resubmittals, deliveries, or Work.
 4. Adjusted or modified sequences of Work.
 5. Other identifiable changes.
 6. Revised projections of progress and completion.
 7. Report of changed logic.
- B. Produce detailed subschedules during Project, upon request of Owner or Engineer, to further define critical portions of the Work such as facility shutdowns.
- C. If an activity is not completed by its latest scheduled completion date and this failure is anticipated to extend Contract Times, submit, within 7 days of such failure, a written statement as to how nonperformance will be corrected to return Project to acceptable current Progress Schedule. Actions by Contractor to complete the Work within Contract Times will not be justification for adjustment to Contract Price or Contract Times.

- D. Owner may order Contractor to increase plant, equipment, labor force, or working hours if Contractor fails to: Satisfactorily execute Work as necessary to prevent delay to overall completion of Project, at no additional cost to Owner.

1.06 NARRATIVE PROGRESS REPORT

A. Format:

- 1. Organize same as Progress Schedule.
- 2. Identify, on a cover letter, reporting period, date submitted, and name of author of report.

B. Contents:

- 1. Number of days worked over the period, work force on hand, construction equipment on hand (including utility vehicles such as pickup trucks, maintenance vehicles, stake trucks).
- 2. General progress of Work, including a listing of activities started and completed over the reporting period, mobilization/demobilization of subcontractors, and major milestones achieved.
- 3. Contractor's plan for management of Site (for example, lay down and staging areas, construction traffic), use of construction equipment, buildup of trade labor, and identification of potential Contract changes.
- 4. Identification of new activities and sequences as a result of executed Contract changes.
- 5. Documentation of weather conditions over the reporting period, and any resulting impacts to the work.
- 6. Description of actual or potential delays, including related causes, and the steps taken or anticipated to mitigate their impact.
- 7. Changes to activity logic.
- 8. Changes to the critical path.
- 9. Identification of, and accompanying reason for, any activities added or deleted since the last report.
- 10. Steps taken to recover the schedule from Contractor-caused delays.

1.07 SCHEDULE ACCEPTANCE

A. Engineer's acceptance will demonstrate agreement that:

- 1. Proposed schedule is accepted with respect to:
 - a. Contract Times, including Final Completion, are within the specified times.
 - b. Specified Work sequences and constraints are shown as specified.
 - c. Access restrictions are accurately reflected.

- d. Startup and testing times are as specified.
- e. Submittal review times are as specified.
- f. Startup testing duration is as specified and timing is acceptable.
- 2. In all other respects, Engineer's acceptance of Contractor's schedule indicates that, in Engineer's judgment, schedule represents reasonable plan for constructing Project in accordance with the Contract Documents. Engineer's review will not make any change in Contract requirements. Lack of comment on any aspect of schedule that is not in accordance with the Contract Documents will not thereby indicate acceptance of that change, unless Contractor has explicitly called the nonconformance to Engineer's attention in submittal. Schedule remains Contractor's responsibility and Contractor retains responsibility for performing all activities, for activity durations, and for activity sequences required to construct Project in accordance with the Contract Documents.

B. Unacceptable Preliminary Progress Schedule:

- 1. Make requested corrections; resubmit within 10 days.
- 2. Until acceptable to Engineer as Baseline Progress Schedule, continue review and revision process, including updating schedule on a monthly basis to reflect actual progress and occurrences to date.

C. Unacceptable Detailed Progress Schedule:

- 1. Make requested corrections; resubmit within 10 days.
- 2. Until acceptable to Engineer as Baseline Progress Schedule, continue review and revision process.

D. Narrative Report: All changes to activity duration and sequences, including addition or deletion of activities subsequent to Engineer's acceptance of Baseline Progress Schedule, shall be delineated in Narrative Report current with proposed Updated Progress Schedule.

1.08 ADJUSTMENT OF CONTRACT TIMES

- A. Reference General Conditions and Section 01 26 00, Contract Modification Procedures.
- B. Evaluation and reconciliation of Adjustments of Contract Times shall be based on the Updated Progress Schedule at the time of proposed adjustment or claimed delay.

C. Schedule Contingency:

1. Contingency, when used in the context of the Progress Schedule, is time between Contractor's proposed Completion Time and Contract Completion Time.
2. Contingency included in Progress Schedule is a Project resource available to both Contractor and Owner to meet Contract Milestones and Contract Times. Use of Schedule contingency shall be shared to the proportionate benefit of both parties.
3. Use of schedule contingency suppression techniques such as preferential sequencing and extended activity times is prohibited.
4. Pursuant to Contingency sharing provisions of this specification, no time extensions will be granted, nor will delay damages be paid until a delay occurs which (i) consumes all available contingency time, and (ii) extends Work beyond the Contract Completion date.

D. Claims Based on Contract Times:

1. Where Engineer has not yet rendered formal decision on Contractor's Claim for adjustment of Contract Times, and parties are unable to agree as to amount of adjustment to be reflected in Progress Schedule, reflect an interim adjustment in the Progress Schedule as acceptable to Engineer.
2. It is understood and agreed that such interim acceptance will not be binding on either Contractor or Owner, and will be made only for the purpose of continuing to schedule Work until such time as formal decision has been rendered as to an adjustment, if any, of the Contract Times.
3. Revise Progress Schedule prepared thereafter in accordance with Engineer's formal decision.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01 33 00
SUBMITTAL PROCEDURES

PART 1 GENERAL

1.01 DEFINITIONS

- A. Action Submittal: Written and graphic information submitted by Contractor that requires Engineer's approval.
- B. Deferred Submittal: Information, in accordance with 2012 Edition of IBC, submitted by Contractor for portions of design that are to be submitted to permitting agency for approval prior to installation of that portion of the Work, along with Engineer's review documentation that submittal has been found to be in general conformance with Project's design.
- C. Informational Submittal: Information submitted by Contractor that requires Engineer's review and determination that submitted information is in accordance with the Conditions of the Contract.

1.02 PROCEDURES

- A. Direct submittals to Engineer at the following, unless specified otherwise.
 - 1. Available at preconstruction conference.
- B. Electronic Submittals: Submittals shall, unless specifically accepted, be made in electronic format.
 - 1. Each submittal shall be an electronic file in Adobe Acrobat Portable Document Format (PDF). Use the latest version available at time of execution of the Agreement.
 - 2. Electronic files that contain more than 10 pages in PDF format shall contain internal bookmarking from an index page to major sections of the document.
 - 3. PDF files shall be set to open "Bookmarks and Page" view.
 - 4. Add general information to each PDF file, including title, subject, author, and keywords.
 - 5. PDF files shall be set up to print legibly at 8.5-inch by 11-inch, 11-inch by 17-inch, or 22-inch by 34-inch. No other paper sizes will be accepted.
 - 6. Submit new electronic files for each resubmittal.
 - 7. Include a copy of the Transmittal of Contractor's Submittal form, located at end of section, with each electronic file.
 - 8. Engineer will reject submittal that is not electronically submitted, unless specifically accepted.

9. Provide Engineer with authorization to reproduce and distribute each file as many times as necessary for Project documentation.
10. Detailed procedures for handling electronic submittals will be discussed at the preconstruction conference.

C. Transmittal of Submittal:

1. Contractor shall:
 - a. Review each submittal and check for compliance with Contract Documents.
 - b. Stamp each submittal with uniform approval stamp before submitting to Engineer.
 - 1) Stamp to include Project name, submittal number, Specification number, Contractor's reviewer name, date of Contractor's approval, and statement certifying submittal has been reviewed, checked, and approved for compliance with Contract Documents.
 - 2) Engineer will not review submittals that do not bear Contractor's approval stamp and will return them without action.
2. Complete, sign, and transmit with each submittal package, one Transmittal of Contractor's Submittal form attached at end of this section.
3. Identify each submittal with the following:
 - a. Numbering and Tracking System:
 - 1) Sequentially number each submittal.
 - 2) Resubmission of submittal shall have original number with sequential alphabetic suffix.
 - b. Specification section and paragraph to which submittal applies.
 - c. Project title and Engineer's project number.
 - d. Date of transmittal.
 - e. Names of Contractor, Subcontractor or Supplier, and manufacturer as appropriate.
4. Identify and describe each deviation or variation from Contract Documents.

D. Format:

1. Do not base Shop Drawings on reproductions of Contract Documents.
2. Package submittal information by individual Specification section. Do not combine different Specification sections together in submittal package, unless otherwise directed in Specification.
3. Present in a clear and thorough manner and in sufficient detail to show kind, size, arrangement, and function of components, materials, and devices, and compliance with Contract Documents.
4. Index with labeled tab dividers in orderly manner.

- E. Timeliness: Schedule and submit in accordance with requirements of individual Specification sections.
- F. Processing Time:
 - 1. Time for review shall commence on Engineer's receipt of submittal.
 - 2. Engineer will act upon Contractor's submittal and transmit response to Contractor not later than 21 days after receipt, unless otherwise specified.
 - 3. Resubmittals will be subject to same review time.
 - 4. No adjustment of Contract Times or Price will be allowed as a result of delays in progress of Work caused by rejection and subsequent resubmittals.
- G. Resubmittals: Clearly identify each correction or change made.
- H. Incomplete Submittals:
 - 1. Engineer will return entire submittal for Contractor's revision if preliminary review deems it incomplete.
 - 2. When any of the following are missing, submittal will be deemed incomplete:
 - a. Contractor's review stamp; completed and signed.
 - b. Transmittal of Contractor's Submittal; completed and signed.
- I. Submittals not required by Contract Documents:
 - 1. Will not be reviewed and will be returned stamped "Not Subject to Review."
 - 2. Engineer will keep one copy and return submittal to Contractor.

1.03 ACTION SUBMITTALS

- A. Prepare and submit Action Submittals required by individual Specification sections.
- B. Shop Drawings:
 - 1. Identify and Indicate:
 - a. Applicable Contract Drawing and Detail number, products, units and assemblies, and system or equipment identification or tag numbers.
 - b. Equipment and Component Title: Identical to title shown on Drawings.

- c. Critical field dimensions and relationships to other critical features of Work. Note dimensions established by field measurement.
 - d. Project-specific information drawn accurately to scale.
 - 2. Manufacturer's standard schematic drawings and diagrams as follows:
 - a. Modify to delete information that is not applicable to the Work.
 - b. Supplement standard information to provide information specifically applicable to the Work.
 - 3. Product Data: Provide as specified in individual specifications.
 - 4. Deferred Submittal: See Drawings for list of deferred submittals.
 - a. Contractor-design drawings and product data related to permanent construction.
 - 1) Written and graphic information.
 - 2) Drawings.
 - 3) Cut sheets.
 - 4) Data sheets.
 - 5) Action item submittals requested in individual Specification section.
 - b. Prior to installation of indicated structural or nonstructural element, equipment, distribution system, or component or its anchorage, submit required supporting data and drawings for review and acceptance by Engineer. Documentation of review and approval provided on Engineer's comment form, along with completed submittal, shall be filed with permitting agency by Contractor and approved by permitting agency prior to installation.
 - 5. Foreign Manufacturers: When proposed, include names and addresses of at least two companies that maintain technical service representatives close to Project.
- C. Action Submittal Dispositions: Engineer will review, comment, stamp, and distribute as noted:
 - 1. Approved:
 - a. Contractor may incorporate product(s) or implement Work covered by submittal.
 - b. Distribution: Electronic.
 - 2. Approved as Noted:
 - a. Contractor may incorporate product(s) or implement Work covered by submittal, in accordance with Engineer's notations.
 - b. Distribution: Electronic.

3. Partial Approval, Resubmit as Noted:
 - a. Make corrections or obtain missing portions, and resubmit.
 - b. Except for portions indicated, Contractor may begin to incorporate product(s) or implement Work covered by submittal, in accordance with Engineer's notations.
 - c. Distribution: Electronic.
4. Revise and Resubmit:
 - a. Contractor may not incorporate product(s) or implement Work covered by submittal.
 - b. Distribution: Electronic.

1.04 INFORMATIONAL SUBMITTALS

A. General:

1. Refer to individual Specification sections for specific submittal requirements.
2. Engineer will review each submittal. If submittal meets conditions of the Contract, Engineer will forward copy to appropriate parties. If Engineer determines submittal does not meet conditions of the Contract and is therefore considered unacceptable, Engineer will retain one copy and return remaining copy with review comments to Contractor, and require that submittal be corrected and resubmitted.

B. Certificates:

1. General:
 - a. Provide notarized statement that includes signature of entity responsible for preparing certification.
 - b. Signed by officer or other individual authorized to sign documents on behalf of that entity.
2. Welding: In accordance with individual Specification sections.
3. Installer: Prepare written statements on manufacturer's letterhead certifying installer complies with requirements as specified in individual Specification section.
4. Material Test: Prepared by qualified testing agency, on testing agency's standard form, indicating and interpreting test results of material for compliance with requirements.
5. Certificates of Successful Testing or Inspection: Submit when testing or inspection is required by Laws and Regulations or governing agency or specified in individual Specification sections.
6. Manufacturer's Certificate of Compliance: In accordance with Section 01 61 00, Common Product Requirements.
7. Manufacturer's Certificate of Proper Installation: In accordance with Section 01 43 33, Manufacturers' Field Services.

- C. Construction Photographs: In accordance with Section 01 31 13, Project Coordination, and as may otherwise be required in Contract Documents.
- D. Closeout Submittals: In accordance with Section 01 77 00, Closeout Procedures.
- E. Contractor-design Data (related to temporary construction):
 - 1. Written and graphic information.
 - 2. List of assumptions.
 - 3. List of performance and design criteria.
 - 4. Summary of loads or load diagram, if applicable.
 - 5. Calculations.
 - 6. List of applicable codes and regulations.
 - 7. Name and version of software.
 - 8. Information requested in individual specification section.
- F. Deferred Submittals: See Drawings for list of deferred submittals.
 - 1. Contractor-design data related to permanent construction:
 - a. List of assumptions.
 - b. List of performance and design criteria.
 - c. Summary of loads or load diagram, if applicable.
 - d. Calculations.
 - e. List of applicable codes and regulations.
 - f. Name and version of design software.
 - g. Factory test results.
 - h. Informational submittals requested in individual Specification section.
 - 2. Prior to installation of indicated structural or nonstructural element, equipment, distribution system, or component or its anchorage, submit calculations and test results of Contractor-designed components for review by Engineer. Documentation of review and indication of compliance with general design intent and project criteria provided on Engineer's comment form as meets conditions of the Contract, along with completed submittal, shall be filed with permitting agency by Contractor and approved by permitting agency prior to installation.
- G. Manufacturer's Instructions: Written or published information that documents manufacturer's recommendations, guidelines, and procedures in accordance with individual Specification section.
- H. Operation and Maintenance Data: As required in Section 01 78 23, Operation and Maintenance Data.

- I. Payment:
 - 1. Application for Payment: In accordance with Section 01 29 00, Payment Procedures.
 - 2. Schedule of Values: In accordance with Section 01 29 00, Payment Procedures.
- J. Quality Control Documentation: As required in Section 01 45 16.13, Contractor Quality Control.
- K. Schedules:
 - 1. Progress Schedules: In accordance with Section 01 32 00, Construction Progress Documentation.
- L. Special Guarantee: Supplier's written guarantee as required in individual Specification sections.
- M. Statement of Qualification: Evidence of qualification, certification, or registration as required in Contract Documents to verify qualifications of professional land surveyor, engineer, materials testing laboratory, specialty Subcontractor, trade, Specialist, consultant, installer, and other professionals. Reference Paragraph 1.01.A.38.b of Supplementary Conditions for definition of Specialist.
- N. Submittals Required by Laws, Regulations, and Governing Agencies:
 - 1. Promptly submit promptly notifications, reports, certifications, payrolls, and otherwise as may be required, directly to the applicable federal, state, or local governing agency or their representative.
 - 2. Transmit to Engineer for Owner's records one copy of correspondence and transmittals (to include enclosures and attachments) between Contractor and governing agency.
- O. Test, Evaluation, and Inspection Reports:
 - 1. General: Shall contain signature of person responsible for test or report.
 - 2. Factory:
 - a. Identification of product and Specification section, type of inspection or test with referenced standard or code.
 - b. Date of test, Project title and number, and name and signature of authorized person.
 - c. Test results.
 - d. If test or inspection deems material or equipment not in compliance with Contract Documents, identify corrective action necessary to bring into compliance.

- e. Provide interpretation of test results, when requested by Engineer.
- f. Other items as identified in individual Specification sections.
- 3. Field:
 - a. As a minimum, include the following:
 - 1) Project title and number.
 - 2) Date and time.
 - 3) Record of temperature and weather conditions.
 - 4) Identification of product and Specification section.
 - 5) Type and location of test, Sample, or inspection, including referenced standard or code.
 - 6) Date issued, testing laboratory name, address, and telephone number, and name and signature of laboratory inspector.
 - 7) If test or inspection deems material or equipment not in compliance with Contract Documents, identify corrective action necessary to bring into compliance.
 - 8) Provide interpretation of test results, when requested by Engineer.
 - 9) Other items as identified in individual Specification sections.

P. Testing and Startup Data: In accordance with Section 01 91 14, Equipment Testing and Facility Startup.

Q. Training Data: In accordance with Section 01 43 33, Manufacturers' Field Services.

1.05 SUPPLEMENTS

A. The supplements listed below, following "End of Section", are part of this Specification.

- 1. Forms: Transmittal of Contractor's Submittal.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

TRANSMITTAL OF CONTRACTOR'S SUBMITTAL (ATTACH TO EACH SUBMITTAL)			
DATE: _____			
TO: _____ _____ _____ _____ _____ FROM: _____ <div style="text-align: center;">Contractor</div> _____ _____ _____	Submittal No.: _____ <input type="checkbox"/> New Submittal <input type="checkbox"/> Resubmittal Project: _____ Project No.: _____ Specification Section No.: _____ (Cover only one section with each transmittal) Schedule Date of Submittal: _____ _____		
SUBMITTAL TYPE:	<input type="checkbox"/> Shop Drawing	<input type="checkbox"/> Sample	<input type="checkbox"/> Informational
	<input type="checkbox"/> Deferred		

The following items are hereby submitted:

Number of Copies	Description of Item Submitted (Type, Size, Model Number, Etc.)	Spec. and Para. No.	Drawing or Brochure Number	Contains Variation to Contract	
				No	Yes

Contractor hereby certifies that (i) Contractor has complied with the requirements of Contract Documents in preparation, review, and submission of designated Submittal and (ii) the Submittal is complete and in accordance with the Contract Documents and requirements of laws and regulations and governing agencies.

By: _____
 Contractor (Authorized Signature)

SECTION 01 42 13
ABBREVIATIONS AND ACRONYMS

PART 1 GENERAL

1.01 REFERENCE TO STANDARDS AND SPECIFICATIONS OF TECHNICAL SOCIETIES

- A. Reference to standards and specifications of technical societies and reporting and resolving discrepancies associated therewith shall be as provided in Article 3 of the General Conditions, and as may otherwise be required herein and in the individual specification sections.
- B. Work specified by reference to published standard or specification of government agency, technical association, trade association, professional society or institute, testing agency, or other organization shall meet requirements or surpass minimum standards of quality for materials and workmanship established by designated standard or specification.
- C. Where so specified, products or workmanship shall also meet or exceed additional prescriptive or performance requirements included within Contract Documents to establish a higher or more stringent standard of quality than required by referenced standard.
- D. Where two or more standards are specified to establish quality, product and workmanship shall meet or exceed requirements of most stringent.
- E. Where both a standard and a brand name are specified for a product in Contract Documents, proprietary product named shall meet or exceed requirements of specified reference standard.
- F. Copies of standards and specifications of technical societies:
 - 1. Copies of applicable referenced standards have not been bound in these Contract Documents.
 - 2. Where copies of standards are needed by Contractor, obtain a copy or copies directly from publication source and maintain in an orderly manner at the Site as Work Site records, available to Contractor's personnel, Subcontractors, Owner, and Engineer.

1.02 ABBREVIATIONS

- A. Abbreviations for trade organizations and government agencies: Following is a list of construction industry organizations and government agencies to which references may be made in the Contract Documents, with abbreviations used.

1.	AA	Aluminum Association
2.	AABC	Associated Air Balance Council
3.	AAMA	American Architectural Manufacturers Association
4.	AASHTO	American Association of State Highway and Transportation Officials
5.	ABMA	American Bearing Manufacturers' Association
6.	ACI	American Concrete Institute
7.	AEIC	Association of Edison Illuminating Companies
8.	AGA	American Gas Association
9.	AGMA	American Gear Manufacturers' Association
10.	AI	Asphalt Institute
11.	AISC	American Institute of Steel Construction
12.	AISI	American Iron and Steel Institute
13.	AITC	American Institute of Timber Construction
14.	ALS	American Lumber Standards
15.	AMCA	Air Movement and Control Association
16.	ANSI	American National Standards Institute
17.	APA	APA – The Engineered Wood Association
18.	API	American Petroleum Institute
19.	APWA	American Public Works Association
20.	AHRI	Air-Conditioning, Heating, and Refrigeration Institute
21.	ASA	Acoustical Society of America
22.	ASABE	American Society of Agricultural and Biological Engineers
23.	ASCE	American Society of Civil Engineers
24.	ASHRAE	American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.
25.	ASME	American Society of Mechanical Engineers
26.	ASNT	American Society for Nondestructive Testing
27.	ASSE	American Society of Sanitary Engineering
28.	ASTM	ASTM International
29.	AWI	Architectural Woodwork Institute
30.	AWPA	American Wood Preservers' Association
31.	AWPI	American Wood Preservers' Institute
32.	AWS	American Welding Society
33.	AWWA	American Water Works Association

34.	BHMA	Builders Hardware Manufacturers' Association
35.	CBM	Certified Ballast Manufacturer
36.	CDA	Copper Development Association
37.	CGA	Compressed Gas Association
38.	CISPI	Cast Iron Soil Pipe Institute
39.	CMAA	Crane Manufacturers' Association of America
40.	CRSI	Concrete Reinforcing Steel Institute
41.	CS	Commercial Standard
42.	CSA	Canadian Standards Association
43.	CSI	Construction Specifications Institute
44.	DIN	Deutsches Institut für Normung e.V.
45.	DIPRA	Ductile Iron Pipe Research Association
46.	EIA	Electronic Industries Alliance
47.	EJCDC	Engineers Joint Contract Documents' Committee
48.	ETL	Electrical Test Laboratories
49.	FAA	Federal Aviation Administration
50.	FCC	Federal Communications Commission
51.	FDA	Food and Drug Administration
52.	FEMA	Federal Emergency Management Agency
53.	FIPS	Federal Information Processing Standards
54.	FM	FM Global
55.	Fed. Spec.	Federal Specifications (FAA Specifications)
56.	FS	Federal Specifications and Standards (Technical Specifications)
57.	GA	Gypsum Association
58.	GANA	Glass Association of North America
59.	HI	Hydraulic Institute
60.	HMI	Hoist Manufacturers' Institute
61.	IBC	International Building Code
62.	ICBO	International Conference of Building Officials
63.	ICC	International Code Council
64.	ICEA	Insulated Cable Engineers' Association
65.	IFC	International Fire Code
66.	IEEE	Institute of Electrical and Electronics Engineers, Inc.
67.	IESNA	Illuminating Engineering Society of North America
68.	IFI	Industrial Fasteners Institute
69.	IGMA	Insulating Glass Manufacturer's Alliance
70.	IMC	International Mechanical Code
71.	INDA	Association of the Nonwoven Fabrics Industry
72.	IPC	International Plumbing Code
73.	ISA	International Society of Automation
74.	ISO	International Organization for Standardization

75.	ITL	Independent Testing Laboratory
76.	JIC	Joint Industry Conferences of Hydraulic Manufacturers
77.	MIA	Marble Institute of America
78.	MIL	Military Specifications
79.	MMA	Monorail Manufacturers' Association
80.	MSS	Manufacturer's Standardization Society
81.	NAAMM	National Association of Architectural Metal Manufacturers
82.	NACE	NACE International
83.	NBGQA	National Building Granite Quarries Association
84.	NEBB	National Environmental Balancing Bureau
85.	NEC	National Electrical Code
86.	NECA	National Electrical Contractor's Association
87.	NEMA	National Electrical Manufacturers' Association
88.	NESC	National Electrical Safety Code
89.	NETA	InterNational Electrical Testing Association
90.	NFPA	National Fire Protection Association
91.	NHLA	National Hardwood Lumber Association
92.	NICET	National Institute for Certification in Engineering Technologies
93.	NIST	National Institute of Standards and Technology
94.	NRCA	National Roofing Contractors Association
95.	NRTL	Nationally Recognized Testing Laboratories
96.	NSF	NSF International
97.	NSPE	National Society of Professional Engineers
98.	NTMA	National Terrazzo and Mosaic Association
99.	NWWDA	National Wood Window and Door Association
100.	OSHA	Occupational Safety and Health Act (both Federal and State)
101.	PCI	Precast/Prestressed Concrete Institute
102.	PEI	Porcelain Enamel Institute
103.	PPI	Plastic Pipe Institute
104.	PS	Product Standards Section-U.S. Department of Commerce
105.	RMA	Rubber Manufacturers' Association
106.	RUS	Rural Utilities Service
107.	SAE	SAE International
108.	SDI	Steel Deck Institute
109.	SDI	Steel Door Institute
110.	SJI	Steel Joist Institute
111.	SMACNA	Sheet Metal and Air Conditioning Contractors National Association
112.	SPI	Society of the Plastics Industry
113.	SSPC	The Society for Protective Coatings

114. STI/SPFA	Steel Tank Institute/Steel Plate Fabricators Association
115. SWI	Steel Window Institute
116. TEMA	Tubular Exchanger Manufacturers' Association
117. TCA	Tile Council of North America
118. TIA	Telecommunications Industry Association
119. UBC	Uniform Building Code
120. UFC	Uniform Fire Code
121. UL	formerly Underwriters Laboratories Inc.
122. UMC	Uniform Mechanical Code
123. USBR	U.S. Bureau of Reclamation
124. WCLIB	West Coast Lumber Inspection Bureau
125. WI	Wood Institute
126. WWPA	Western Wood Products Association

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01 43 33
MANUFACTURERS' FIELD SERVICES

PART 1 GENERAL

1.01 DEFINITIONS

- A. Person-Day: One person for 8 hours within regular Contractor working hours.

1.02 SUBMITTALS

- A. Informational Submittals:

1. Training Schedule: Submit, in accordance with requirements of this Specification, not less than 21 days prior to start of equipment installation and revise as necessary for acceptance.
2. Lesson Plan: Submit, in accordance with requirements of this Specification, proposed lesson plan not less than 21 days prior to scheduled training and revise as necessary for acceptance.
3. Training Session Recordings: Furnish Owner with two complete sets of recordings fully indexed and cataloged with printed label stating session and date recorded.

1.03 QUALIFICATION OF MANUFACTURER'S REPRESENTATIVE

- A. Authorized representative of the manufacturer shall be factory trained and experienced in the technical applications, installation, operation, and maintenance of respective equipment, subsystem, or system, with full authority by the equipment manufacturer to issue the certifications required of the manufacturer. Additional qualifications may be specified in the individual Specification section.
- B. Representative subject to acceptance by Owner and Engineer. No substitute representatives will be allowed unless prior written approval by such has been given.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 FULFILLMENT OF SPECIFIED MINIMUM SERVICES

- A. Furnish manufacturers' services, when required by an individual Specification section, to meet the requirements of this section.

- B. Where time is necessary in excess of that stated in the Specifications for manufacturers' services, or when a minimum time is not specified, time required to perform specified services shall be considered incidental.
- C. Schedule manufacturer's services to avoid conflict with other onsite testing or other manufacturers' onsite services.
- D. Determine, before scheduling services, that conditions necessary to allow successful testing have been met.
- E. Only those days of service approved by Engineer will be credited to fulfill specified minimum services.
- F. When specified in individual Specification sections, manufacturer's onsite services shall include:
 - 1. Assistance during product (system, subsystem, or component) installation to include observation, guidance, instruction of Contractor's assembly, erection, installation or application procedures.
 - 2. Inspection, checking, and adjustment as required for product (system, subsystem, or component) to function as warranted by manufacturer and necessary to furnish Manufacturer's Certificate of Proper Installation.
 - 3. Providing, on a daily basis, copies of manufacturers' representatives field notes and data to Engineer.
 - 4. Revisiting the Site as required to correct problems and until installation and operation are acceptable to Engineer.
 - 5. Resolution of assembly or installation problems attributable to or associated with respective manufacturer's products and systems.
 - 6. Assistance during functional and performance testing, and facility startup and evaluation.
 - 7. Training of Owner's personnel in the operation and maintenance of respective product as required.

3.02 MANUFACTURER'S CERTIFICATE OF PROPER INSTALLATION

- A. When so specified, a Manufacturer's Certificate of Proper Installation form, a copy of which is attached to this section, shall be completed and signed by equipment manufacturer's representative.
- B. Such form shall certify signing party is a duly authorized representative of manufacturer, is empowered by manufacturer to inspect, approve, and operate their equipment and is authorized to make recommendations required to ensure equipment is complete and operational.

3.03 TRAINING

A. General:

1. Furnish manufacturers' representatives for detailed classroom and hands-on training to Owner's personnel on operation and maintenance of specified product (system, subsystem, component) and as may be required in applicable Specifications.
2. Furnish trained, articulate personnel to coordinate and expedite training, to be present during training coordination meetings with Owner, and familiar with operation and maintenance manual information specified in Section 01 78 23, Operation and Maintenance Data.
3. Manufacturer's representative shall be familiar with facility operation and maintenance requirements as well as with specified equipment.
4. Furnish complete training materials, to include operation and maintenance data, to be retained by each trainee.

B. Training Schedule:

1. List specified equipment and systems that require training services and show:
 - a. Respective manufacturer.
 - b. Estimated dates for installation completion.
 - c. Estimated training dates.
2. Allow for multiple sessions when several shifts are involved.
3. Adjust schedule to ensure training of appropriate personnel as deemed necessary by Owner, and to allow full participation by manufacturers' representatives. Adjust schedule for interruptions in operability of equipment.
4. Coordinate with Section 01 32 00, Construction Progress Documentation, and Section 01 91 14, Equipment Testing and Facility Startup.

C. Lesson Plan: When manufacturer or vendor training of Owner personnel is specified, prepare a lesson plan for each required course containing the following minimum information:

1. Title and objectives.
2. Recommended attendees (such as, managers, engineers, operators, maintenance).
3. Course description, outline of course content, and estimated class duration.
4. Format (such as, lecture, self-study, demonstration, hands-on).
5. Instruction materials and equipment requirements.
6. Resumes of instructors providing training.

D. Prestartup Training:

1. Coordinate training sessions with Owner's operating personnel and manufacturers' representatives, and with submission of operation and maintenance manuals in accordance with Section 01 78 23, Operation and Maintenance Data.
2. Complete at least 14 days prior to beginning of facility startup.

E. Post-startup Training: If required in Specifications, furnish and coordinate training of Owner's operating personnel by respective manufacturer's representatives.

F. Recording of Training Sessions:

1. Furnish audio and color recording of prestartup and post-startup instruction sessions, including manufacturers' representatives' hands-on equipment instruction and classroom sessions.
2. Video training materials shall be produced by a qualified, professional video production company.
3. Use DVD format suitable for playback on standard equipment available commercially in the United States. Blu-ray® DVD format is not acceptable without Engineer's prior approval.

3.04 SUPPLEMENTS

A. The supplement listed below, following "End of Section," is part of this Specification.

1. Manufacturer's Certificate of Proper Installation.

END OF SECTION

MANUFACTURER'S CERTIFICATE OF PROPER INSTALLATION

OWNER _____ EQPT SERIAL NO: _____

EQPT TAG NO: _____ EQPT/SYSTEM: _____

PROJECT NO: _____ SPEC. SECTION: _____

I hereby certify that the above-referenced equipment/system has been:

(Check Applicable)

- ☐ Installed in accordance with Manufacturer's recommendations.
- ☐ Inspected, checked, and adjusted.
- ☐ Serviced with proper initial lubricants.
- ☐ Electrical and mechanical connections meet quality and safety standards.
- ☐ All applicable safety equipment has been properly installed.
- ☐ Functional tests.
- ☐ System has been performance tested, and meets or exceeds specified performance requirements. (When complete system of one manufacturer)

Note: Attach any performance test documentation from manufacturer.

Comments: _____

I, the undersigned Manufacturer's Representative, hereby certify that I am (i) a duly authorized representative of the manufacturer, (ii) empowered by the manufacturer to inspect, approve, and operate their equipment and (iii) authorized to make recommendations required to ensure equipment furnished by the manufacturer is complete and operational, except as may be otherwise indicated herein. I further certify that all information contained herein is true and accurate.

Date: _____, 20____

Manufacturer: _____

By Manufacturer's Authorized Representative: _____

(Authorized Signature)

SECTION 01 45 16.13
CONTRACTOR QUALITY CONTROL

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. ASTM International (ASTM):
 - a. D3740, Evaluation of Agencies Engaged in the Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction.
 - b. E329, Use in the Evaluation of Testing and Inspection Agencies as Used in Construction.

1.02 DEFINITIONS

A. Contractor Quality Control (CQC): The means by which Contractor ensures that the construction, to include that performed by subcontractors and suppliers, complies with the requirements of the Contract.

1.03 OWNER'S QUALITY ASSURANCE

A. All Work is subject to Owner's quality assurance inspection and testing at all locations and at all reasonable times before acceptance to ensure strict compliance with the terms of the Contract Documents.

B. Owner's quality assurance inspections and tests are for the sole benefit of Owner and do not:

1. Relieve Contractor of responsibility for providing adequate quality control measures;
2. Relieve Contractor of responsibility for damage to or loss of the material before acceptance;
3. Constitute or imply acceptance; or
4. Affect the continuing rights of Owner after acceptance of the completed Work.

C. The presence or absence of a quality assurance inspector does not relieve Contractor from any Contract requirement.

- D. Promptly furnish all facilities, labor, and material reasonably needed for performing such safe and convenient inspections and tests as may be required by Engineer.
- E. Owner may charge Contractor for any additional cost of inspection or test when Work is not ready at the time specified by Contractor for inspection or test, or when prior rejection makes re-inspection or retest necessary. Quality assurance inspections and tests will be performed in a manner that will not unnecessarily delay the Work.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 GENERAL

- A. Maintain an adequate inspection system and perform such inspections as will ensure that the Work conforms to the Contract Documents.
- B. Maintain complete inspection records and make them available at all times to Owner and Engineer.
- C. The quality control system shall consist of plans, procedures, and organization necessary to produce an end product that complies with the Contract Documents. The system shall cover all construction and demolition operations, including Work by subcontractors, fabricators, suppliers and purchasing agents, and shall be keyed to the proposed construction sequence.

3.02 COORDINATION MEETING

- A. After the Preconstruction Conference, but before start of construction, and prior to acceptance of the CQC Plan, schedule a meeting with Engineer and Owner to discuss the quality control system.
- B. Develop a mutual understanding of the system details, including the forms for recording the CQC operations, control activities, testing, administration of the system for both onsite and offsite Work, and the interrelationship of Contractor's management and control with the Owner's Quality Assurance.
- C. There may be occasions when subsequent conferences may be called by either party to reconfirm mutual understandings and/or address deficiencies in the CQC system or procedures that may require corrective action by Contractor.

3.03 QUALITY CONTROL ORGANIZATION

A. CQC System Manager:

1. Designate an individual within Contractor's organization who will be responsible for overall management of CQC and have the authority to act in CQC matters for the Contractor.
2. CQC System Manager may perform other duties on the Project.
3. CQC System Manager shall be an experienced construction person, with a minimum of 3 years construction experience on similar type Work.
4. CQC System Manager shall report to the Contractor's project manager or someone higher in the organization. Project manager in this context shall mean the individual with responsibility for the overall quality and production management of the Project.
5. CQC System Manager shall be onsite during construction; periods of absence may not exceed 2 weeks at any one time.
6. Identify an alternate for CQC System Manager to serve with full authority during the System Manager's absence. The requirements for the alternate will be the same as for designated CQC System Manager.

B. CQC Staff:

1. Designate a CQC staff, available at the Site at all times during progress, with complete authority to take any action necessary to ensure compliance with the Contract. CQC staff members shall be subject to acceptance by Engineer.
2. CQC staff shall take direction from CQC System Manager in matters pertaining to QC.
3. CQC staff must be of sufficient size to ensure adequate QC coverage of Work phases, work shifts, and work crews involved in the construction. These personnel may perform other duties, but must be fully qualified by experience and technical training to perform their assigned QC responsibilities and must be allowed sufficient time to carry out these responsibilities.
4. The actual strength of the CQC staff may vary during any specific Work period to cover the needs of the Project. Add additional staff when necessary for a proper CQC organization.

- C. Organizational Changes: Obtain Engineer's acceptance before replacing any member of the CQC staff. Requests for changes shall include name, qualifications, duties, and responsibilities of the proposed replacement.

3.04 QUALITY CONTROL PHASING

- A. CQC shall include at least three phases of control to be conducted by CQC System Manager for all definable features of Work, as follows:
1. Preparatory Phase:
 - a. This phase shall include a meeting conducted by the CQC System Manager and attended by the superintendent, other CQC personnel (as applicable), and the foreman responsible for the definable feature. The CQC System Manager shall instruct applicable CQC staff as to the acceptable level of workmanship required in order to meet Contract requirements.
 - b. Document the results of the preparatory phase meeting by separate minutes prepared by the CQC System Manager and attached to the QC report.
 - c. Perform prior to beginning Work on each definable feature of Work:
 - 1) Review applicable Contract Specifications.
 - 2) Review applicable Contract Drawings.
 - 3) Verify that all materials and/or equipment have been tested, submitted, and approved.
 - 4) Verify that provisions have been made to provide required control inspection and testing.
 - 5) Examine the Work area to verify that all required preliminary Work has been completed and is in compliance with the Contract.
 - 6) Perform a physical examination of required materials, equipment, and sample Work to verify that they are on hand, conform to approved Shop Drawing or submitted data, and are properly stored.
 - 7) Review the appropriate activity hazard analysis to verify safety requirements are met.
 - 8) Review procedures for constructing the Work, including repetitive deficiencies.
 - 9) Document construction tolerances and workmanship standards for that phase of the Work.
 2. Initial Phase:
 - a. Accomplish at the beginning of a definable feature of Work:
 - 1) Perform prior to beginning Work on each definable feature of Work:
 - a) Review minutes of the preparatory meeting.
 - b) Check preliminary Work to verify compliance with Contract requirements.
 - c) Verify required control inspection and testing.

- d) Establish level of workmanship and verify that it meets minimum acceptable workmanship standards. Comparison with sample panels is appropriate.
 - e) Resolve all differences.
 - f) Check safety to include compliance with and upgrading of the safety plan and activity hazard analysis. Review the activity analysis with each worker.
 - 2) Separate minutes of this phase shall be prepared by the CQC System Manager and attached to the QC report. Exact location of initial phase shall be indicated for future reference and comparison with follow-up phases.
 - 3) The initial phase should be repeated for each new crew to work onsite, or any time acceptable specified quality standards are not being met.
3. Follow-up Phase:
- a. Perform daily checks to verify continuing compliance with Contract requirements, including control testing, until completion of the particular feature of Work.
 - b. Daily checks shall be made a matter of record in the CQC documentation and shall document specific results of inspections for all features of Work for the day or shift.
 - c. Conduct final follow-up checks and correct all deficiencies prior to the start of additional features of Work that will be affected by the deficient Work. Constructing upon or concealing nonconforming Work will not be allowed.
4. Additional Preparatory and Initial Phases: Additional preparatory and initial phases may be conducted on the same definable features of Work as determined by Owner if the quality of ongoing Work is unacceptable; or if there are changes in the applicable QC staff or in the onsite production supervision or work crew; or if work on a definable feature is resumed after a substantial period of inactivity, or if other problems develop.

3.05 CONTRACTOR QUALITY CONTROL PLAN

A. General:

- 1. Plan shall identify personnel, procedures, control, instructions, test, records, and forms to be used.
- 2. An interim plan for the first 30 days of operation will be considered.

3. Construction will be permitted to begin only after acceptance of the CQC Plan or acceptance of an interim plan applicable to the particular feature of Work to be started.
4. Work outside of the features of Work included in an accepted interim plan will not be permitted to begin until acceptance of a CQC Plan or another interim plan containing the additional features of Work to be started.

B. Content:

1. Plan shall cover the intended CQC organization for the entire Contract and shall include the following, as a minimum:
 - a. Organization: Description of the quality control organization, including acknowledgment that the CQC staff will implement the three-phase control system (see Paragraph QC Phasing) for all aspects of the Work specified.
 - b. CQC Staff: The name, qualifications (in resume format), duties, responsibilities, and authorities of each person assigned a QC function.
 - c. Testing: Control, verification and acceptance testing procedures for each specific test to include the test name, frequency, specification paragraph containing the test requirements, the personnel and laboratory responsible for each type of test, and an estimate of the number of tests required.
 - d. Procedures for tracking preparatory, initial, and follow-up control phases and control, verification, and acceptance tests, including documentation.
 - e. Procedures for tracking deficiencies from identification through acceptable corrective action. These procedures will establish verification that identified deficiencies have been corrected.
 - f. Reporting procedures, including proposed reporting formats; include a copy of the CQC report form.

C. Acceptance of Plans: Acceptance of the Contractor's basic and addendum CQC plans is required prior to the start of construction. Acceptance is conditional and will be predicated on satisfactory performance during the construction. Owner reserves the right to require Contractor to make changes in the CQC plan and operations including removal of personnel, as necessary, to obtain the quality specified.

D. Notification of Changes: After acceptance of the CQC plan, Contractor shall notify Engineer, in writing, a minimum of 7 calendar days prior to any proposed change. Proposed changes are subject to acceptance by Engineer.

3.06 CONTRACTOR QUALITY CONTROL REPORT

- A. As a minimum, prepare a CQC report for every 14 calendar days. Account for all days throughout the life of the Contract. Reports shall be signed and dated by CQC System Manager. Include copies of test reports and copies of reports prepared by QC staff.
- B. Maintain current records of quality control operations, activities, and tests performed, including the Work of subcontractors and suppliers.
- C. Records shall be on an acceptable form and shall be a complete description of inspections, the results of inspections, daily activities, tests, and other items, including but not limited to the following:
 - 1. Contractor/subcontractor and their areas of responsibility.
 - 2. Operating plant/equipment with hours worked, idle, or down for repair.
 - 3. Work performed today, giving location, description, and by whom. When a network schedule is used, identify each phase of Work performed each day by activity number.
 - 4. Test and/or control activities performed with results and references to specifications/plan requirements. The control phase should be identified (Preparatory, Initial, Follow-up). List deficiencies noted along with corrective action.
 - 5. Material received with statement as to its acceptability and storage.
 - 6. Job safety evaluations stating what was checked, results, and instructions or corrective actions.
 - 7. List instructions given/received and conflicts in Drawings and/or Specifications.
 - 8. Contractor's verification statement.
 - 9. Indicate a description of trades working on the Project; the number of personnel working; weather conditions encountered; and any delays encountered.
 - 10. These records shall cover both conforming and deficient features and shall include a statement that equipment and materials incorporated in file work and workmanship comply with the Contract.

3.07 SUBMITTAL QUALITY CONTROL

- A. Submittals shall be as specified in Section 01 33 00, Submittal Procedures. The CQC organization shall be responsible for certifying that all submittals are in compliance with the Contract requirements. Owner will furnish copies of test report forms upon request by Contractor. Contractor may use other forms as approved.

3.08 TESTING QUALITY CONTROL

A. Testing Procedure:

1. Perform tests specified or required to verify that control measures are adequate to provide a product which conforms to Contract requirements. Procure services of a licensed testing laboratory to be selected by the Owner. Perform the following activities and record the following data:
 - a. Verify testing procedures comply with contract requirements.
 - b. Verify facilities and testing equipment are available and comply with testing standards.
 - c. Check test instrument calibration data against certified standards.
 - d. Verify recording forms and test identification control number system, including all of the test documentation requirements, have been prepared.
 - e. Documentation:
 - 1) Record results of all tests taken, both passing and failing, on the CQC report for the date taken.
 - 2) Include specification paragraph reference, location where tests were taken, and the sequential control number identifying the test.
 - 3) Actual test reports may be submitted later, if approved by Engineer, with a reference to the test number and date taken.
 - 4) Provide directly to Engineer an information copy of tests performed by an offsite or commercial test facility. Test results shall be signed by an engineer registered in the state where the tests are performed.
 - 5) Failure to submit timely test reports, as stated, may result in nonpayment for related Work performed and disapproval of the test facility for this Contract.

- B. Testing Laboratories: Laboratory facilities, including personnel and equipment, utilized for testing soils, concrete, asphalt and steel shall meet criteria detailed in ASTM D3740 and ASTM E329, and be accredited by the American Association of Laboratory Accreditation (AALA), National Institute of Standards and Technology (NIST), National Voluntary Laboratory Accreditation Program (NVLAP), the American Association of State Highway and Transportation Officials (AASHTO), or other approved national accreditation authority. Personnel performing concrete testing shall be certified by the American Concrete Institute (ACI).

3.09 COMPLETION INSPECTION

- A. CQC System Manager shall conduct an inspection of the Work at the completion of all Work.
- B. Punchlist:
 - 1. CQC System Manager shall develop a punchlist of items which do not conform to the Contract requirements.
 - 2. Include punchlist in the CQC report, indicating the estimated date by which the deficiencies will be corrected.
 - 3. CQC System Manager or staff shall make a second inspection to ascertain that all deficiencies have been corrected and so notify the Owner.
 - 4. These inspections and any deficiency corrections required will be accomplished within the time stated for completion of the entire Work or any particular increment thereof if the Project is divided into increments by separate completion dates.

END OF SECTION

SECTION 01 45 33
SPECIAL INSPECTION, OBSERVATION, AND TESTING

PART 1 GENERAL

1.01 SUMMARY

- A. This section covers requirements for Special Inspection, Observation, and Testing required in accordance with Chapter 17 of the 2012 International Building Code, the 2012, 2014, 2015, 2017 and 2018 Georgia State Amendments to the IBC and is in addition to and supplements requirements included in Statement of Special Inspections shown in supplement located at end of this section.

1.02 REFERENCES

- A. The following is a list of standards which may be referenced in this section:

1. American Society of Civil Engineers (ASCE): 7, Minimum Design Loads for Buildings and Other Structures.
2. International Code Council (ICC):
 - a. 2012 International Building Code (IBC).
 - b. 2012, 2014, 2015, 2017 and 2018 State of Georgia Amendments to the International Building Code.
 - c. Evaluation Service (ICC-ES) Reports and Legacy Reports.

1.03 DEFINITIONS

- A. Agencies and Personnel:

1. Agency Having Jurisdiction (AHJ): Permitting building agency; may be a federal, state, local, or other regional department, or individual including building official, fire chief, fire marshal, chief of a fire prevention bureau, labor department, or health department, electrical inspector; or others having statutory authority. AHJ may be Owner when authorized to be self-permitting by governmental permitting agency or when no governmental agency has authority.
2. Approved Agency: An established and recognized agency regularly engaged in conducting tests or furnishing inspection services, when such agency has been approved.

3. Registered Design Professional in Responsible Charge: An individual who is registered or licensed to practice their respective design profession as defined by statutory requirements of professional registration laws of state or jurisdiction in which Project is to be constructed.
 4. Special Inspector: Qualified person employed by Owner who will demonstrate competence to the satisfaction of AHJ for inspection of a particular type of construction or operation requiring Special Inspection.
- B. Statement of Special Inspections: Detailed written procedure contained in supplement located at end of this section establishing systems and components subject to Special Inspection, Observation, and Testing during construction, type and frequency of testing, extent and duration of Special Inspection, and reports to be completed and distributed by Special Inspector.
- C. Special Inspection:
1. Special Inspection: Inspection required of materials, installation, fabrication, erection, or placement of components and connections requiring special expertise to ensure compliance with approved Contract Documents and referenced standards.
 2. Special Inspection, Continuous: Full-time observation of work requiring Special Inspection by an approved Special Inspector who is present in area where the Work is being performed.
 3. Special Inspection, Periodic: Part-time or intermittent observation of the Work requiring Special Inspection by an approved Special Inspector who is present in area where the Work has been or is being performed, and at completion of the Work.
- D. Structural Systems and Components:
1. Diaphragm: Component of structural lateral load resisting system consisting of roof, floor, or other membrane or bracing system acting to transfer lateral forces to vertical resisting elements of structure.
 2. Drag Strut or Collector: Component of structural lateral load resisting system consisting of diaphragm or shear wall element that collects and transfers diaphragm shear forces to vertical force-resisting elements or distributes forces within diaphragm or shear wall.
 3. Seismic-Force-Resisting System: That part of structural lateral load resisting system that has been considered in the design to provide required resistance to seismic forces identified on Drawings.

4. Shear Wall: Component of structural lateral load resisting system consisting of a wall designed to resist lateral forces parallel to plane of the wall. Unless noted otherwise on Drawings, load-bearing walls with direct in-plane connections to roof and floors shall be considered to be shear walls.
5. Wind Force Resisting System: That part of the structural system that has been considered in the design to provide required resistance to wind forces identified on Drawings.

E. Nonstructural Components:

1. Architectural Component Supports: Structural members or assemblies of members which transmit loads and forces from architectural systems or components to structure, including braces, frames, struts, and attachments.
2. Electrical Component Supports: Structural members or assemblies which transmit loads and forces from electrical equipment to structure, including braces, frames, legs, pedestals, and tethers, as well as elements forged or cast as part of component for anchorage.
3. Mechanical Component Supports: Structural members or assemblies which transmit loads and forces from mechanical equipment to structure, including braces, frames, skirts, legs, saddles, pedestals, snubbers, and tethers, as well as elements forged or cast as part of component for anchorage.

F. Professional Observation:

1. Does not include or waive responsibility for required Special Inspection or inspections by building official.
2. Requirements are indicated on Statement of Special Inspections provided in supplement located at end of this section.
3. Geotechnical Observation: Visual observation of selected subgrade bearing surfaces by a registered design professional for general conformance to Contract Documents.
4. Structural Observation: Visual observation of structural system(s) by a registered design professional for general conformance to Contract Documents.

1.04 SUBMITTALS

A. Informational Submittals:

1. Contractor's Statement of Responsibility: Form shall be completed by entity responsible for construction of main wind-force-resisting system, and main seismic-force-resisting system, wind-resisting component, and seismic-resisting component listed in Statement of Special Inspections. Refer to Article Supplements located at end of section.
2. Fabricator's Certificate of Compliance: Form shall be completed by entity responsible for shop fabrication of structural load-bearing members and assemblies. Refer to Article Supplements located at end of section.

1.05 STATEMENT OF SPECIAL INSPECTIONS REQUIREMENTS

A. Designated Systems for Inspection:

1. Seismic-force-resisting systems designated under IBC Section 1705 and subject to Special Inspection under Section 1705: See Drawings for basic lateral load resisting systems for each structure and other designated seismic systems.
2. Wind-force-resisting systems designated under IBC Section 1705: See Drawings for basic lateral load resisting systems for each structure and other designated wind-resisting components.
3. Architectural, Mechanical, and Electrical Components subject to Special Inspection under IBC Section 1705.11.5, 1705.11.6, and 1705.12 for Seismic Resistance: As listed in Section 01 45 36, Equipment Seismic Certification.

B. Statement of Special Inspections:

1. As included in supplement located at the end of this section and in support of building permit application, Project-specific requirements were prepared by Registered Design Professional in Responsible Charge. The following identifies elements of inspection, observation, and testing program to be followed in construction of the Work:
 - a. Designated seismic systems and main seismic force and wind-force-resisting systems and components that are subject to Special Inspection and Structural Observation for lateral load resistance.
 - b. Special Inspection and testing required by IBC 1705 and other applicable sections and referenced standards therein.
 - c. Type and frequency of Special Inspection required.
 - d. Type and frequency of testing required.

- e. Required frequency and distribution of testing and Special Inspection reports to be distributed by Special Inspector to Engineer, Contractor, building official, and Owner.
 - f. Geotechnical Observation to be Performed: Required frequency and distribution of Geotechnical Observation reports by registered design professional to Contractor, building official, and Owner.
 - g. Structural Observations to be Performed: Required frequency and distribution of Structural Observation reports by registered design professional to Contractor, building official, and Owner.
- C. Special Inspection and associated testing of shop fabrication and field construction will be performed by an approved accredited independent agency or by Authority Having Jurisdiction's (AHJ) approved, qualified inspection staff. Owner will secure and pay for services of agency to perform Special Inspection and associated testing.
- D. Code required Special Inspection with associated testing and Professional Observation, as provided in Statement of Special Inspections in supplement located at the end of this section and further provided in this section, is for benefit of Owner and does not:
- 1. Relieve Contractor of responsibility for providing adequate quality control measures.
 - 2. Relieve Contractor of responsibility for damage to or loss of material before acceptance.
 - 3. Constitute or imply acceptance.
 - 4. Affect continuing rights of Owner after acceptance of completed Work.
- E. The presence or absence of code required Special Inspector and Professional Observer does not relieve Contractor from Contract requirements.
- F. Contractor is responsible for additional costs associated with Special Inspection and Testing and Observation when Work is not ready at time identified by Contractor and Special Inspectors and Professional Observer are onsite, but not able to provide contracted services.
- G. Contractor is responsible for associated costs for additional Special Inspection and Testing and Professional Observation by Special Inspectors and Professional Observers required because of rejection of materials of in place Work that cannot be made compliant to Contract Document without additional inspections and observation and testing.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 GENERAL

- A. Requirements of the Statement of Special Inspections are provided by the Owner. All other testing and inspections, unless noted otherwise, are provided by Contractor.
- B. Provide access to shop or Site for Special Inspection and Testing and Professional Observation requirements.
- C. Notify Engineer in advance of required Special Inspection and Professional Observation no later than 48 hours prior to date of Special Inspection and Professional Observation.
- D. Provide access for Special Inspector to construction documents.
- E. Retain special inspection records on-site to be readily available for review.
- F. Cooperate with Special Inspector and provide safe access to the Work to be inspected.
- G. Submit Fabricator's Certificates of Compliance for approved fabricators.
- H. Provide reasonable auxiliary services as requested by the Special Inspector. Auxiliary services required include, but not limited to:
 - 1. Providing access to the Work and furnishing incidental labor and facilities necessary to facilitate inspections and tests to assist the Special Inspector in performing test/inspections.
 - 2. Providing storage space for the Special Inspector's exclusive use, such as for storing and curing concrete test samples and delivery of samples to testing laboratories.
 - 3. Providing the Special Inspector with access to all approved submittals.
 - 4. Providing security and protection of samples and test equipment at the Project Site.
 - 5. Provide samples of materials to be tested in required quantities.
- I. When required by Registered Design Professional in Responsible Charge, provide access for mechanical and electrical component inspections for those items requiring certification.
- J. Materials and systems shall be inspected during placement where Continuous Special Inspection is required.

K. Where Periodic Special Inspection is indicated in the Statement of Special Inspections:

1. Schedule inspections for either during or at completion of their placement or a combination of both.
2. Schedule periodically inspected Work (either inspected during or after its placement) so that corrections can be completed and re-inspected before Work is inaccessible.
3. Sampling a portion of the Work is not allowed. Schedules shall provide for inspection of all Work requiring periodic inspection.

3.02 SUPPLEMENTS

A. The supplements listed below, following “End of Section,” are a part of this Specification:

1. Contractor’s Statement of Responsibility.
2. Fabricator’s Certificate of Compliance.
3. Statement of Special Inspections.
4. Special Inspection and Observation Tables 1 – 6.
5. Structural Observation Table 7.

END OF SECTION

CONTRACTOR'S STATEMENT OF RESPONSIBILITY

 (Project)

 (Name of Contracting Company)

 (Business Address)

 (_____) _____
 (Telephone)

 (_____) _____
 (Fax)

I, (We) hereby certify that I am (we are) aware of the Special Inspection and Testing and Professional Observation and component certification requirements contained in Contract Documents for this Project for wind and seismic force-resisting systems, and for components including architectural, mechanical, and electrical components, as listed in Statement of Special Inspections in supplement located at the end of this section and Section 01 45 36, Equipment Seismic Certification, and that:

- I, (We) aware of the systems and the requirements of the special inspection and acknowledge our responsibility in the implementation of the Statement of Special Inspections for the construction of the following systems:

Facility	Specification	Lateral Force-Resisting System
20 – Chlorine Dioxide System Canopy		Aluminum moment resisting frame systems

- I, (We) are responsible for construction of the following components:**

Facility	Component
20 – Chlorine Dioxide System	Purate Storage Tank
20 – Chlorine Dioxide System	Sulfuric Acid Storage Tank

3. Control of this Work will be exercised to obtain conformance with Contract Documents approved by building official.
4. Procedures within the Contractor's organization to be used for exercising control of the Work, method and frequency of reporting, and distribution of reports required under Statement of Special Inspections for Project are attached to this statement.
5. I, (We) will provide 48-hour notification to Engineer and approved inspection agency as required for structural tests and Special Inspection for Project.
6. The following person is hereby identified as exercising control over requirements of this section for the Work designated above:

Name: _____

Qualifications: _____

(Print name and official title of person signing this form)

Signed by: _____

Date: _____

Project Name: _____

FABRICATOR'S CERTIFICATE OF COMPLIANCE

Each approved fabricator that is exempt from Special Inspection of shop fabrication and implementation procedures per section 1704.2.5 of 2012 IBC must submit Fabricator's Certificate of Compliance at the completion of fabrication.

(Project)

(Fabricator's Name)

(Business Address)

(Certification or Approval Agency)

(Certification Number)

(Date of Last Audit or Approval)

Description of structural members and assemblies that have been fabricated:

I hereby certify that items described above were fabricated in strict accordance with approved construction documents.

(Name and Title) type or print

(Signature and Date)

Attach copies of fabricator's certification or building code evaluation service report and fabricator's quality control manual.

STATEMENT OF SPECIAL INSPECTIONS

GENERAL NOTES

1. SPECIAL INSPECTION REPORTS AND A FINAL REPORT IN ACCORDANCE WITH 2012 IBC AND GEORGIA AMENDMENTS, SECTION 1704.2.4 SHALL BE SUBMITTED TO THE BUILDING OFFICIAL PRIOR TO THE TIME THAT PHASE OF THE WORK IS APPROVED FOR OCCUPANCY.
2. SPECIAL INSPECTOR QUALIFICATIONS SHALL BE IN ACCORDANCE WITH 2014 GEORGIA AMENDMENTS SECTION 1704.2.1.
3. STANDARD SPECIAL INSPECTION REQUIREMENTS FOR NONSTRUCTURAL COMPONENTS ARE CONTAINED IN TABLE 1.
4. STANDARD SPECIAL INSPECTION REQUIREMENTS FOR STRUCTURAL COMPONENTS, REGARDLESS OF WIND OR SEISMIC DESIGN CATEGORIES, ARE CONTAINED IN TABLE 2. STANDARD TESTING REQUIREMENTS FOR STRUCTURAL COMPONENTS ARE CONTAINED IN TABLE 3.
5. PROJECT SPECIFIC REQUIREMENTS FOR STRUCTURES ASSIGNED TO SEISMIC DESIGN CATEGORIES C, D, E, OR F ARE CONTAINED IN TABLE 4. ADDITIONAL TESTING REQUIREMENTS FOR STRUCTURAL RESISTANCE ARE CONTAINED IN TABLE 6.
6. PROJECT SPECIFIC REQUIREMENTS FOR STRUCTURES SUBJECT TO BASIC WIND SPEEDS (V_{asd}) IN EXCESS OF 110 MPH ARE CONTAINED IN TABLE 5.
7. FOR ADDITIONAL REQUIREMENTS, REFER TO SPECIFICATION SECTION 01 45 33, SPECIAL INSPECTION, OBSERVATION, AND TESTING. THESE INCLUDE:
 - A. CONTRACTOR'S REQUIREMENTS TO PROVIDE ACCESS TO THE WORK FOR REQUIRED INSPECTIONS, AND TO PROVIDE NOTICE OF REQUIRED INSPECTIONS AND STRUCTURAL OBSERVATION.
 - B. CONTRACTOR'S STATEMENT OF RESPONSIBILITY FOR WORK TO BE PERFORMED ON SYSTEMS DESIGNATED UNDER THE STATEMENT OF SPECIAL INSPECTIONS FOR WIND OR SEISMIC RESISTANCE.
 - C. DEFINITIONS AND TERMINOLOGY USED IN THIS STATEMENT OF SPECIAL INSPECTIONS.

SPECIAL INSPECTION

1. SPECIAL INSPECTION WILL BE IN ACCORDANCE WITH IBC SECTIONS 1704 AND 1705 TOGETHER WITH LOCAL AND STATE AMENDMENTS. REFER TO THE FOLLOWING TABLES FOR PROJECT SPECIFIC INSPECTION TYPES AND FREQUENCIES.
2. SPECIAL INSPECTIONS WILL BE PROVIDED BY A CERTIFIED OR QUALIFIED INSPECTOR AND ASSOCIATED TESTING WILL BE PERFORMED BY AN

APPROVED ACCREDITED INDEPENDENT AGENCY. THE OWNER WILL SECURE AND PAY FOR THE SERVICES OF THE AGENCY TO PERFORM ALL SPECIAL INSPECTION AND ASSOCIATED TESTS. INSPECTORS FOR EACH SYSTEM AND MATERIAL WILL BE INTERNATIONAL CODE COUNCIL (ICC) CERTIFIED OR OTHERWISE APPROVED BY THE BUILDING OFFICIAL.

3. THE SPECIAL INSPECTOR WILL OBSERVE THE INDICATED WORK FOR COMPLIANCE WITH THE APPROVED CONTRACT DOCUMENTS AND SUBMIT RECORDS OF INSPECTION. ALL DISCREPANCIES WILL BE BROUGHT TO THE IMMEDIATE ATTENTION OF THE CONTRACTOR FOR CORRECTION.
4. SPECIAL INSPECTION AND ASSOCIATED TESTING REPORTS WILL BE SUBMITTED TO THE ENGINEER, CONTRACTOR, BUILDING OFFICIAL, AND OWNER WITHIN ONE WEEK OF INSPECTION OR WITHIN ONE WEEK OF TEST COMPLETION. INSPECTIONS FOR WHICH REPORTING WILL BE REQUIRED ARE NOTED IN THE FOLLOWING TABLES.
5. AT THE CONCLUSION OF CONSTRUCTION, A FINAL REPORT DOCUMENTING REQUIRED SPECIAL INSPECTIONS AND CORRECTION OF PREVIOUSLY NOTED DISCREPANCIES WILL BE SUBMITTED.

GEOTECHNICAL OBSERVATION

1. ALL FOUNDATION BEARING SURFACES SHALL BE INSPECTED BY GEOTECHNICAL ENGINEER PRIOR TO PLACEMENT OF REINFORCING STEEL. ADDITIONAL SPECIAL INSPECTION REQUIREMENTS ARE LISTED IN TABLE 1.
2. GEOTECHNICAL TESTING REQUIREMENTS ARE LISTED IN TABLE 3.

STRUCTURAL OBSERVATION

1. STRUCTURAL OBSERVATION WILL BE IN ACCORDANCE WITH IBC SECTION 1704.5 TOGETHER WITH LOCAL AND STATE AMENDMENTS.
2. ONSITE STRUCTURAL OBSERVATION WILL BE PERFORMED FOR EACH IDENTIFIED SEISMIC FORCE- OR WIND FORCE-RESISTING SYSTEM, INCLUDING FOUNDATIONS AND CONNECTIONS. REFER TO THE INDIVIDUAL STRUCTURAL DRAWINGS FOR THE BASIC SEISMIC AND WIND FORCE-RESISTING SYSTEMS FOR THE STRUCTURES INCLUDED IN THE WORK.
3. STRUCTURAL OBSERVATION WILL BE PERFORMED BY A REGISTERED PROJECT DESIGN PROFESSIONAL FOR GENERAL CONFORMANCE TO THE APPROVED CONSTRUCTION DOCUMENTS. STRUCTURAL OBSERVATION DOES NOT INCLUDE OR WAIVE THE RESPONSIBILITY FOR ANY REQUIRED SPECIAL INSPECTIONS OR INSPECTIONS BY THE BUILDING OFFICIAL.
4. STRUCTURAL OBSERVATION REPORTS, NOTING ANY DEFICIENCIES IN OBSERVED CONSTRUCTION, WILL BE DELIVERED TO THE CONTRACTOR, BUILDING OFFICIAL, AND OWNER FOLLOWING EACH OBSERVATION. THE

CONTRACTOR WILL BE NOTIFIED ONSITE OR BY PHONE OR E-MAIL WITHIN 24 HOURS UPON FINDING DEFICIENCIES.

5. AT THE CONCLUSION OF CONSTRUCTION, A WRITTEN STATEMENT WILL BE PROVIDED TO VERIFY THAT THE STRUCTURAL OBSERVATION SITE VISITS WERE MADE AND WHETHER THERE REMAIN ANY STRUCTURAL DEFICIENCIES THAT HAVE NOT BEEN RESOLVED.
6. STRUCTURAL OBSERVATION WILL INCLUDE VISUAL OBSERVATION OF THE STRUCTURAL SYSTEM AT SIGNIFICANT CONSTRUCTION STAGES AND AT COMPLETION OF THE STRUCTURAL SYSTEM FOR EACH STRUCTURE CONTAINED IN THE WORK. THE CONTRACTOR SHALL SCHEDULE AND FACILITATE STRUCTURAL OBSERVATION, INCLUDING THE ELEMENTS DESCRIBED IN THE STRUCTURAL OBSERVATION TABLES (ATTACHED).

SPECIAL INSPECTIONS FOR WIND RESISTANCE

1. SPECIAL INSPECTIONS REQUIREMENTS FOR WIND RESISTANCE IN ACCORDANCE WITH IBC SECTION 1705.10 ARE NOT APPLICABLE TO THIS PROJECT.

SPECIAL INSPECTIONS FOR SEISMIC RESISTANCE

1. SPECIAL INSPECTIONS REQUIREMENTS FOR SEISMIC RESISTANCE WILL BE IN ACCORDANCE WITH IBC SECTION 1705.11 AND 1705.12 TOGETHER WITH LOCAL AND STATE AMENDMENTS. REFER TO INDIVIDUAL STRUCTURE DRAWINGS FOR BASIC SEISMIC-FORCE-RESISTING SYSTEMS FOR EACH STRUCTURE AND DESIGNATED SEISMIC DESIGN CATEGORY.
2. SPECIAL INSPECTIONS REQUIREMENTS FOR SEISMIC RESISTANCE SHALL APPLY TO THE SYSTEMS AND COMPONENTS LISTED IN TABLE 4.
3. MAIN SYSTEMS REQUIRED TO BE COVERED UNDER PROJECT SPECIAL INSPECTION REQUIREMENTS INCLUDE THE FOLLOWING TOGETHER WITH THEIR CONNECTIONS. REFER TO SECTION 01 45 33, SPECIAL INSPECTION, OBSERVATION AND TESTING.

Statement of Special Inspections Prepared by:

Type or Print Name

Signature

Date

Preparer's Seal

TABLE 1 REQUIRED NON-STRUCTURAL SPECIAL INSPECTION REFER TO SPECIFICATION SECTION 01 45 33							
SYSTEM OR MATERIAL	2012 IBC CODE REFERENCE	REFERENCED STANDARD	PERIODIC OWNER FURNISHED SPECIAL INSPECTION (SEE NOTE 1)	CONTINUOUS OWNER FURNISHED SPECIAL INSPECTION	REQUIRED REPORTING BY SPECIAL INSPECTOR TO DESIGNATED DISTRIBUTION LIST	COMMENTS	TESTING FOR SPECIAL INSPECTION
GEOTECHNICAL							
1. SOILS:							
A. VERIFY MATERIALS BELOW SHALLOW FOUNDATIONS ARE ADEQUATE TO ACHIEVE THE DESIGN BEARING CAPACITY	1705.6, 1803.5.8, 1803.5.9, 1804.5	SECTION 31 23 13, SUBGRADE PREPARATION	X		X	PROFESSIONAL OBSERVATION BY GEOTECHNICAL ENGINEER	SEE TABLE 3 FOR CLSM STRENGTH TEST REQUIREMENTS
B. VERIFY EXCAVATIONS ARE EXTENDED TO PROPER DEPTH AND HAVE REACHED PROPER MATERIAL	1705.6 31 23 16	1705.6 SECTION 31 23 16, EXCAVATION	X	1705.6	X	PROFESSIONAL OBSERVATION BY GEOTECHNICAL ENGINEER	
C. PERFORM CLASSIFICATION AND TESTING OF COMPACTED FILL MATERIALS	1705.6	SECTION 31 23 23, FILL AND BACKFILL	X		X		SEE TABLE 3 FOR GRADATION TEST REQUIREMENTS
D. VERIFY USE OF PROPER MATERIALS, DENSITIES, AND LIFT THICKNESSES DURING PLACEMENT AND COMPACTION OF COMPACTED FILL	1705.6, 1803.5.8	SECTION 31 23 23, FILL AND BACKFILL		X	X		SEE TABLE 3 FOR DENSITY TEST REQUIREMENTS
E. PRIOR TO PLACEMENT OF COMPACTED FILL, OBSERVE SUBGRADE AND VERIFY THAT SITE HAS BEEN PREPARED PROPERLY	1705.6	SECTION 31 23 13, SUBGRADE PREPARATION	X		X	PROFESSIONAL OBSERVATION BY GEOTECHNICAL ENGINEER	SEE TABLE 3 FOR DENSITY TEST AND PROOF ROLLING REQUIREMENTS
GENERAL							
1. CONSTRUCTION MATERIALS AND SYSTEMS THAT ARE ALTERNATIVES TO MATERIALS AND SYSTEMS PRESCRIBED BY CODE	1705.1.1 ITEM 1		X		X		
2. UNUSUAL DESIGN APPLICATION OF CODE MATERIALS	1705.1.1 ITEM 2			X	X		
3. INSTALLATION OF MATERIALS THAT REQUIRE ADDITIONAL MANUFACTURER'S INSTRUCTIONS BEYOND CODE REQUIREMENTS	1703.4.2, 1705.1.1 ITEM 3	ICC-ES EVALUATION REPORTS		X	X		
STRUCTURAL							
SEE TABLE 2.							

NOTES:

1. PERIODIC INSPECTION IS DEFINED AS INSPECTION BY THE SPECIAL INSPECTOR OF ALL MATERIALS AND SYSTEMS, IN SOME CASES PERFORMED DURING THEIR PLACEMENT AND IN ALL CASES PERFORMED UPON COMPLETION OF THEIR PLACEMENT. THE COMPLETION INSPECTION SHALL BE PERFORMED SO THAT WORK CAN BE CORRECTED PRIOR TO OTHER RELATED WORK PROCEEDING

TABLE 2 REQUIRED STRUCTURAL SPECIAL INSPECTION REFER TO SPECIFICATION SECTION 01 45 33							TESTING FOR SPECIAL INSPECTION
SYSTEM	2012 IBC CODE REFERENCE	REFERENCED STANDARD	PERIODIC OWNER FURNISHED SPECIAL INSPECTION (SEE NOTE 1)	CONTINUOUS OWNER FURNISHED SPECIAL INSPECTION	REQUIRED REPORTING BY SPECIAL INSPECTOR TO DESIGNATED DISTRIBUTION LIST	COMMENTS	
CONCRETE							
1. INSPECTION OF REINFORCING STEEL AND PLACEMENT	1705.3, 1903.1	ACI 318: 3.5, 7.1-7.7	X		X		
2. INSPECTION OF ANCHORS CAST IN CONCRETE	1705.3, 1908.5, 1909.1	ACI 318: 8.1.3, 21.2.8	X		X		
3. INSPECTION OF ANCHORS POST-INSTALLED IN HARDENED CONCRETE MEMBERS	1705.3, 1909.1	ACI 318: 3.8.6, 8.1.3, 21.2.8, ICC-ES EVALUATION REPORTS	X		X	PROVIDE CONTINUOUS SPECIAL INSPECTION FOR ADHESIVE ANCHORS DESIGNED TO RESIST SUSTAINED TENSION LOADS AND WHERE REQUIRED BY ICC- ES REPORT	
4. VERIFYING USE OF REQUIRED DESIGN MIX	1705.3, 1904.2, 1910.2, 1910.3	ACI 318: Ch. 4, 5.2-5.4	X		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	1705.3, 1910.10	ASTM C 172, ASTM C 31, ACI 318: 5.6, 5.8		X	X		SEE TABLE 3 FOR CONCRETE TEST REQUIREMENTS
6. INSPECTION OF CONCRETE PLACEMENT FOR PROPER APPLICATION TECHNIQUES	1705.3, 1910.6, 1910.7, 1910.8	ACI 318: 5.9, 5.10		X	X		

TABLE 2 REQUIRED STRUCTURAL SPECIAL INSPECTION REFER TO SPECIFICATION SECTION 01 45 33							
SYSTEM	2012 IBC CODE REFERENCE	REFERENCED STANDARD	PERIODIC OWNER FURNISHED SPECIAL INSPECTION (SEE NOTE 1)	CONTINUOUS OWNER FURNISHED SPECIAL INSPECTION	REQUIRED REPORTING BY SPECIAL INSPECTOR TO DESIGNATED DISTRIBUTION LIST	COMMENTS	TESTING FOR SPECIAL INSPECTION
7. INSPECTION FOR MAINTENANCE OF SPECIFIED CURING TEMPERATURE AND TECHNIQUES	1705.3	ACI 318: 5.11-5.13	X		X		
8. INSPECT FORMWORK FOR SHAPE, LOCATION AND DIMENSIONS OF THE CONCRETE MEMBER BEING FORMED	1705.3, 1906.1	ACI 318: 6.1.1	X		X		
9. INSPECTION OF WATERSTOPS FOR PROPER SHAPE, LOCATION, JOINT QUALITY, AND SURROUNDING CONCRETE PLACEMENT			X		X		
10. VERIFY PROPER INSTALLATION OF MECHANICAL REINFORCING SPLICES AND CONNECTIONS	1705.1.1 ITEM 3, 1705.3	ICC-ES EVALUATION REPORTS	X		X		
STEEL CONSTRUCTION OTHER THAN STRUCTURAL STEEL							
1. MATERIAL VERIFICATION OF COLD-FORMED STEEL DECK:							
A. IDENTIFICATION MARKINGS TO CONFORM TO ASTM STANDARDS SPECIFIED IN THE APPROVED CONSTRUCTION DOCUMENTS	1705.2.2, 2203.1	Applicable ASTM Material Standards	X		X		
B. MANUFACTURER'S CERTIFIED TEST REPORTS	1705.2.2		X				
ALUMINUM							
1. MATERIAL VERIFICATION OF ALUMINUM:							

TABLE 2 REQUIRED STRUCTURAL SPECIAL INSPECTION REFER TO SPECIFICATION SECTION 01 45 33							
SYSTEM	2012 IBC CODE REFERENCE	REFERENCED STANDARD	PERIODIC OWNER FURNISHED SPECIAL INSPECTION (SEE NOTE 1)	CONTINUOUS OWNER FURNISHED SPECIAL INSPECTION	REQUIRED REPORTING BY SPECIAL INSPECTOR TO DESIGNATED DISTRIBUTION LIST	COMMENTS	TESTING FOR SPECIAL INSPECTION
A. IDENTIFICATION MARKINGS TO CONFORM TO ASTM STANDARDS SPECIFIED IN THE APPROVED CONSTRUCTION DOCUMENTS	1705.1.1 ITEM 2		x		x		
B. MANUFACTURERS' CERTIFIED MILL TEST REPORTS	1705.1.1 ITEM 2		x		x		
2. MATERIAL VERIFICATION OF WELD FILLER MATERIALS:							
A. IDENTIFICATION MARKINGS CONFORM TO AWS SPECIFICATIONS IN THE APPROVED CONSTRUCTION DOCUMENTS	1705.1.1 ITEM 2		x		x		
B. MANUFACTURER'S CERTIFICATES OF COMPLIANCE REQUIRED	1705.1.1 ITEM 2		x		x		
3. INSPECTION OF WELDING:							
A. SINGLE-PASS FILLET WELDS	1705.1.1 ITEM 2	AWS D1.2	x		x		
B. WELDED SHEET FOR ALUMINUM MEMBERS	1705.1.1 ITEM 2	AWS D1.2	x		x		

NOTES:

1. PERIODIC INSPECTION IS DEFINED AS INSPECTION BY THE SPECIAL INSPECTOR OF ALL MATERIALS AND SYSTEMS, IN SOME CASES PERFORMED DURING THEIR PLACEMENT AND IN ALL CASES PERFORMED UPON COMPLETION OF THEIR PLACEMENT. THE COMPLETION INSPECTION SHALL BE PERFORMED SO THAT WORK CAN BE CORRECTED PRIOR TO OTHER RELATED WORK PROCEEDING

TABLE 3 TESTING FOR REQUIRED SPECIAL INSPECTION REFER TO SPECIFICATION SECTION 01 45 33							
MATERIAL	TYPE OR SCOPE	STANDARD	2012 IBC CODE REFERENCE	FREQUENCY	BY WHOM	REQUIRED REPORTING TO DESIGNATED DISTRIBUTION LIST	COMMENTS
GEOTECHNICAL							
CONTROLLED FILL	GRADATION	ASTM D422	1704.7	SECTION 31 23 23, FILL AND BACKFILL	OWNER'S APPROVED TESTING AGENCY	X	
CONTROLLED FILL	COMPACTION	ASTM D698, D1557	1704.7	SECTION 31 23 23, FILL AND BACKFILL	OWNER'S APPROVED TESTING AGENCY	X	
CONTROLLED FILL	DENSITY	ASTM D1556, D6938	1704.7	SECTION 31 23 23, FILL AND BACKFILL	OWNER'S APPROVED TESTING AGENCY	X	
PREPARED SUBGRADE	DENSITY	ASTM D1556, D6938	1704.7	SECTION 31 23 13, SUBGRADE PREPARATION	OWNER'S APPROVED TESTING AGENCY	X	
CONCRETE							
CONCRETE	STRENGTH	ASTM C39	1704.4, 1905.6	ONCE EACH DAY, BUT NOT LESS THAN ONE SAMPLE FOR EACH 150 CUBIC YARDS OR 5,000 SFT OF WALLS OR SLABS PLACED	OWNER'S TESTING AGENCY	X	
CONCRETE	SLUMP	ASTM C143, C94	1704.4	ONE SAMPLE PER STRENGTH TEST	OWNER'S TESTING AGENCY	X	
CONCRETE	AIR CONTENT	ASTM C231, C94	1704.4	ONE SAMPLE PER STRENGTH TEST	OWNER'S TESTING AGENCY	X	
CONCRETE	TEMPERATURE	ASTM C1064	1704.4	ONE SAMPLE PER STRENGTH TEST	OWNER'S TESTING AGENCY	X	

TABLE 4

**REQUIRED SPECIAL INSPECTION FOR SEISMIC RESISTANCE FOR STRUCTURAL SYSTEMS
REFER TO TABLE 2 FOR STANDARD STRUCTURAL SPECIAL INSPECTION REQUIREMENTS
REFER TO SPECIFICATION SECTION 01 45 33**

The Seismic Design Category (SDC) for this Project is D.

SYSTEM	INSPECTION REQUIRED FOR FOLLOWING SEISMIC DESIGN CATEGORIES	2012 IBC CODE REFERENCE	PERIODIC OWNER FURNISHED SPECIAL INSPECTION (SEE NOTE 1)	CONTINUOUS OWNER FURNISHED SPECIAL INSPECTION	COMMENTS	TESTING FOR SPECIAL INSPECTION
ELECTRICAL						
INSTALLATION OF ANCHORAGE OF ELECTRICAL EQUIPMENT FOR EMERGENCY OR STANDBY POWER SYSTEMS	"C" AND ABOVE	1705.11.6 ITEM 1	X		NOTES 2 & 3	
INSTALLATION OF PIPING INTENDED TO EQUIPMENT USING COMBUSTIBLE ENERGY SOURCES	"C" AND ABOVE	1705.11.6 ITEM 1			NOTES 2 & 3	
INSTALLATION OF VIBRATION ISOLATION SYSTEMS WHERE THE CONSTRUCTION DOCUMENTS REQUIRE A NOMINAL CLEARANCE OF 0.25 INCHES OR LESS BETWEEN THE EQUIPMENT SUPPORT FRAME AND RESTRAINT	"C" AND ABOVE	1705.11.6 ITEM 5	X		NOTES 2 & 3	
INSTALLATION OF OTHER SEISMIC SUPPORTS FOR DESIGNATED ELECTRICAL SYSTEMS AND THEIR COMPONENTS	"C" AND ABOVE	1705.11.6	X		NOTES 2 & 3	SEE TABLE 6
PROCESS MECHANICAL						
INSTALLATION OF PIPING SYSTEMS MEANT TO CARRY HAZARDOUS MATERIALS AND ITS ASSOCIATED MECHANICAL UNITS	"C" AND ABOVE	1705.11.6 ITEM 3	X			
INSTALLATION OF OTHER SEISMIC SUPPORTS FOR DESIGNATED MECHANICAL SYSTEMS AND THEIR COMPONENTS	"C" AND ABOVE	1705.11.6	X		NOTES 2 & 3	SEE TABLE 6
BUILDING MECHANICAL						
INSTALLATION OF OTHER SEISMIC SUPPORTS FOR DESIGNATED MECHANICAL SYSTEMS AND THEIR COMPONENTS	"C" AND ABOVE	1705.11.6	X		NOTES 2 & 3	SEE TABLE 6
STRUCTURAL						
STRUCTURAL STEEL INSPECTION OF SEISMIC-FORCE-RESISTING SYSTEMS	"C" AND ABOVE	1705.11.1, AISC 341		X		SEE TABLE 6 FOR STRUCTURAL STEEL TESTING

TABLE 4

**REQUIRED SPECIAL INSPECTION FOR SEISMIC RESISTANCE FOR STRUCTURAL SYSTEMS
REFER TO TABLE 2 FOR STANDARD STRUCTURAL SPECIAL INSPECTION REQUIREMENTS
REFER TO SPECIFICATION SECTION 01 45 33**

The Seismic Design Category (SDC) for this Project is D.

SYSTEM	INSPECTION REQUIRED FOR FOLLOWING SEISMIC DESIGN CATEGORIES	2012 IBC CODE REFERENCE	PERIODIC OWNER FURNISHED SPECIAL INSPECTION (SEE NOTE 1)	CONTINUOUS OWNER FURNISHED SPECIAL INSPECTION	COMMENTS	TESTING FOR SPECIAL INSPECTION
COLD FORMED STEEL LIGHT-FRAMED CONSTRUCTION: WELDING, SCREW ATTACHMENT, BOLTING, ANCHORING AND OTHER FASTENINGS WITHIN THE SEISMIC FORCE- RESISTING SYSTEM INCLUDING SHEAR WALLS, BRACES, DIAPHRAGMS, COLLECTORS (DRAG STRUTS), AND HOLD- DOWNS	"C" AND ABOVE	1705.11.3	X		NOTE 4	
INSPECT AND VERIFY THAT THE DESIGNATED SEISMIC SYSTEM COMPONENTS ARE LABELED AND ANCHORAGE OR MOUNTING CONFORMS TO THE CERTIFICATE OF COMPLIANCE	"C" AND ABOVE	1705.11.4	X			

NOTES:

1. PERIODIC INSPECTION IS DEFINED AS INSPECTION BY THE SPECIAL INSPECTOR OF ALL MATERIALS AND SYSTEMS, IN SOME CASES PERFORMED DURING THEIR PLACEMENT AND IN ALL CASES PERFORMED UPON COMPLETION OF THEIR PLACEMENT. THE COMPLETION INSPECTION SHALL BE PERFORMED SO THAT WORK CAN BE CORRECTED PRIOR TO OTHER RELATED WORK PROCEEDING AND COVERING THE INSPECTED WORK
2. TESTING OF SYSTEMS AND THEIR ANCHORAGE SHALL BE IN CONFORMANCE WITH 2012 IBC SECTION 1705.12.3.
3. CERTIFICATION OF SYSTEMS AND THEIR ANCHORAGE SHALL BE IN CONFORMANCE WITH 2012 IBC SECTION 1705.12.3.
4. NOT REQUIRED IF SHEATHING IS GYPSUM BOARD OR FIBERBOARD OR IF SHEATHING IS WOOD STRUCTURAL PANEL OR STEEL SHEETS ON ONE SIDE OF PANEL OR DIAPHRAGM ONLY AND THE FASTENER SPACING IS MORE THAN 4 INCHES.

TABLE 5
REQUIRED SPECIAL INSPECTION FOR WIND RESISTANCE FOR STRUCTURAL SYSTEMS
REFER TO SPECIFICATION SECTION 01 45 33

The Nominal Design Wind Speed (3-second-gust) for this project is 93 mph.
The Wind Exposure is Category C

NOT REQUIRED

TABLE 6 TESTING FOR SEISMIC RESISTANCE REFER TO SPECIFICATION SECTION 01 45 33							
MATERIAL	TYPE OR SCOPE	STANDARD	2012 IBC CODE REFERENCE	FREQUENCY	BY WHOM	REQUIRED REPORTING TO DESIGNATED DISTRIBUTION LIST	COMMENTS
OTHER							
DESIGNATED SEISMIC SYSTEM COMPONENTS (AND ASSOCIATED ANCHORAGES) SUBJECT TO PROVISIONS OF ASCE 7 SECTION 13.2.2	CERTIFICATE OF COMPLIANCE	ASCE 7 SECTION 13.2.2	1708.4 ITEM 1	EACH SYSTEM OR COMPONENT	MANUFACTURER	X	NOTE 2
DESIGNATED SEISMIC SYSTEM COMPONENTS (AND ASSOCIATED ANCHORAGES) SUBJECT TO PROVISIONS OF ASCE 7 SECTION 13.2.1	CERTIFICATE OF COMPLIANCE	ASCE 7 SECTION 13.2.1	1708.4 ITEM 2	EACH SYSTEM OR COMPONENT	MANUFACTURER	X	NOTE 2

NOTES:

1. TESTING AND QUALIFICATION FOR SEISMIC RESISTANCE ARE REQUIRED FOR SEISMIC-FORCE-RESISTING SYSTEMS IN STRUCTURES ASSIGNED TO SEISMIC DESIGN CATEGORY C, D, E, OR F, UNLESS OTHERWISE NOTED.
2. BASED ON ACTUAL TEST ON SHAKE TABLE, BY THREE-DIMENSIONAL SHOCK TESTS, BY AN ANALYTICAL METHOD USING DYNAMIC CHARACTERISTICS AND FORCES, BY THE USE OF EXPERIENCE DATA, OR BY MORE RIGOROUS ANALYSIS PROVIDING FOR EQUIVALENT SAFETY.

TABLE 7 STRUCTURAL OBSERVATIONS				
COMPONENT OR SYSTEM	FACILITY	STAGE	ITEMS	COMMENTS
FOUNDATION SLAB OF STRUCTURE	20	PRIOR TO FIRST CONCRETE PLACEMENT OF FIRST SECTION WHEN ITEMS CAN STILL BE REVISED	REINFORCING STEEL, CONCRETE WALL DOWELS, WATERSTOPS, EMBEDS, AND SIMILAR ITEMS	NOTE 1
CONCRETE WALLS OF STRUCTURE	20	PRIOR TO FIRST CONCRETE PLACEMENT OF FIRST SECTION WHEN ITEMS CAN STILL BE REVISED	REINFORCING STEEL, WALL DOWELS, WATERSTOPS, EMBEDS, AND SIMILAR ITEMS	NOTE 1
SYSTEM CONNECTION EMBEDS	20	PRIOR TO GROUT OR CONCRETE PLACEMENT		NOTE 1
AT ADDITIONAL TIMES DURING CONSTRUCTION AT WHICH THE ENGINEER OF RECORD OR OWNER DEEM THE NEED FOR ADDITIONAL STRUCTURAL OBSERVATION				NOTE 1
AT SUBSTANTIAL COMPLETION OF PRIMARY STRUCTURAL SYSTEM FOR DETERMINATION OF FINAL CONDITION OF STRUCTURE	20			NOTE 1

NOTES:

1. STRUCTURAL OBSERVER TO DISCUSS ITEMS AND SITE SPECIFIC CONDITIONS WITH SPECIAL INSPECTOR AND FIELD INSPECTION STAFF DURING OBSERVATION.

SECTION 01 45 36
EQUIPMENT SEISMIC CERTIFICATION

PART 1 GENERAL

1.01 SUMMARY

- A. This section covers the code required seismic certification of mechanical and electrical equipment in accordance with 2012 IBC, Chapter 17, and the 2012, 2014, 2015, 2017 and 2018 Georgia State Amendments to the IBC.

1.02 REFERENCES

- A. The following is a list of standards which may be referenced in this section:
1. American Society of Civil Engineers (ASCE): 7, Minimum Design Loads for Buildings and Other Structures.
 2. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
 - a. 344, Recommended Practice for Seismic Qualification of Class 1E Equipment for Nuclear Power Generating Stations.
 - b. 693, Recommended Practice for Seismic Design of Substations.
 3. International Code Council (ICC):
 - a. International Building Code (IBC).
 - b. Evaluation Service (ICC-ES) Reports and Legacy Reports.
 4. National Fire Protection Association (NFPA): 13, Standard for Installation of Sprinkler Systems.

1.03 DEFINITIONS

- A. Agencies and Personnel:
1. Approved Agency: An established and recognized agency regularly engaged in conducting tests or furnishing inspection services, when such agency has been approved.
- B. Component Supports:
1. Electrical: Structural members or assemblies which transmit loads and forces from electrical equipment to the structure, including braces, frames, legs, pedestals, and tethers, as well as elements forged or cast as part of component for anchorage.
 2. Mechanical: Structural members or assemblies which transmit loads and forces from mechanical equipment to the structure, including braces, frames, skirts, legs, saddles, pedestals, snubbers, and tethers, as well as elements forged or cast as part of component for anchorage.

1.04 SUBMITTALS

A. Informational Submittals:

1. Seismic Qualification of Mechanical and Electrical Equipment Certification of Compliance: Submit for mechanical and electrical components having a component importance factor of 1.5 as designated herein. Submit for other components having component importance factor of 1.0 where test results are submitted as an alternate to required calculations under 13.2.5 of ASCE 7-10. Refer to Article Supplements located at end of section.
2. If required by Engineer, submit documentation of testing results or analytical data.

1.05 STATEMENT OF SPECIAL INSPECTIONS (PLAN) REQUIREMENTS

- A. Complete special inspection and testing in accordance with Section 01 45 33, Special Inspection, Observation, and Testing.
- B. Architectural, mechanical, and electrical components subject to special inspection and testing under IBC Section 1705.11 for seismic resistance, as listed in table in Article Mechanical and Electrical Component Certification are in addition to requirements of Section 01 45 33, Special Inspection, Observation, and Testing.

PART 2 PRODUCTS (NOT USED)**PART 3 EXECUTION**

3.01 MECHANICAL AND ELECTRICAL COMPONENT CERTIFICATION

- A. Provide certificate of compliance for mechanical and electrical component testing and certification on form located at end of section. Provide certificates for equipment and components listed in the following table:

Mechanical and Electrical Components Requiring Certification of Compliance for Seismic Testing or Analysis under IBC Section 1705.12.3			
Facility	Component	Component Importance Factor, I_p	Component to Remain Operable?
20 – Chlorine Dioxide System	Purate Storage Tank	1.5	Yes
20 – Chlorine Dioxide System	Sulfuric Acid Storage Tank	1.5	Yes

- B. Certify mechanical and electrical components listed in table above on basis of tests on a shaking table, by three-dimensional shock tests, by an analytical method using dynamic characteristics, and forces as provided in Section 01 88 15, Anchorage and Bracing, experience data demonstrating acceptable seismic performance, or by more rigorous analysis. Submitted testing and experience data shall meet requirements of ASCE 7-10 Section 13.2.5 and Section 13.2.6, respectively.
- C. Component and attachment testing and certification shall be in accordance with applicable provisions of Section 1705.12.3. Seismic testing and certification is in addition to functional and performance testing required for new equipment for field quality control or startup testing as indicated in technical specification.
- D. Where equipment is required to remain operable following the design earthquake ground motion, active parts or energized components shall be certified on basis of approved shake table testing or experience only unless demonstrably similar to other equipment so qualified.
- E. Components with hazardous contents shall be certified to contain materials under the design earthquake.

3.02 SUPPLEMENTS

- A. The supplement listed below, following “End of Section,” is a part of this specification:
 - 1. Seismic Qualification of Mechanical and Electrical Equipment Certificate of Compliance.

END OF SECTION

SEISMIC QUALIFICATION OF MECHANICAL AND ELECTRICAL EQUIPMENT CERTIFICATE OF COMPLIANCE

 (Component under Certification)

 (Name of Manufacturer)

 (Tag Number or Equipment ID)

 (Business Address)

 (Drawing/Detail Number)

 (_____)

 (Telephone)

This is to certify that above-referenced component meets or exceeds requirements of Section 1705.12.3 of 2012 IBC for seismic qualification of equipment. Basis of qualification is by:

(Check Applicable)

- ☐ Shake-table Test
- ☐ Three-dimensional Shock Test
- ☐ Analytical Method
- ☐ Experience Data
- ☐ Conformance with NFPA 13 and force and displacement requirements of Sections 13.3.1 and 13.3.2 of ASCE 7-10 for fire protection sprinkler systems.
- ☐ Other _____

under acceptance criteria of:

- ☐ ICC-ES AC156, Acceptance Criteria for Seismic Qualification by Shake-Table Testing of Nonstructural Components and Systems
- ☐ IEEE 693, IEEE Recommended Practice for Seismic Design of Substations
- ☐ IEEE 344, IEEE Recommended Standard Practice for Seismic Qualification of Class 1E Equipment for Nuclear Power Generating Stations for experience data
- ☐ ASCE 7-10 Chapter 13 for analytical methods
- ☐ Other _____

for the following earthquake hazard rating:

IEEE Seismic Qualification Level: _____

Mapped MCE, 5 Percent Damped, Short Period Spectral Response
Acceleration, S_s : _____

Design, 5 Percent Damped, Short Period Spectral Response
Acceleration, S_{DS} : _____

Component Importance Factor, I_p : _____

Component Response Modification Factor, R_p : _____

Height of Point of Attachment as Factor of Average Roof Height,
 z/h : _____

This certification covers both the integrity of the equipment and anchorage of equipment. Required mounting and anchorage details are shown on attached Seismic Outline Drawing for the most seismically vulnerable component covered by this certification.

Manufacturer's Representative Signature: _____

Address: _____

Date: _____

SECTION 01 50 00
TEMPORARY FACILITIES AND CONTROLS

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American Association of Nurserymen (AAN): American Standards for Nursery Stock.
2. Federal Emergency Management Agency (FEMA).
3. National Fire Prevention Association (NFPA): 241, Standard for Safeguarding Construction, Alteration, and Demolition Operations.
4. Telecommunications Industry Association (TIA); Electronic Industries Alliance (EIA): 568B, Commercial Building Telecommunications Cabling Standard.
5. U.S. Department of Agriculture (USDA): Urban Hydrology for Small Watersheds.
6. U.S. Weather Bureau: Rainfall-Frequency Atlas of the U.S. for Durations from 30 Minutes to 24 Hours and Return Periods from 1 to 100 Years.

1.02 SUBMITTALS

A. Informational Submittals: Copies of permits and approvals for construction as required by Laws and Regulations and governing agencies.

1.03 MOBILIZATION

A. Mobilization includes, but is not limited to, these principal items:

1. Obtaining required permits.
2. Moving Contractor's field office and equipment required for first month operations onto Site.
3. Installing temporary construction power, wiring, and lighting facilities.
4. Providing onsite sanitary facilities and potable water facilities as specified and as required by Laws and Regulations, and governing agencies.
5. Arranging for and erection of Contractor's work and storage yard.
6. Posting OSHA required notices and establishing safety programs and procedures.

B. Use area designated for Contractor's temporary facilities as shown on Drawings.

1.04 PROTECTION OF WORK AND PROPERTY

- A. Comply with Owner's safety rules while on Owner's property.
- B. Keep Owner informed of serious onsite accidents and related claims.
- C. Use of Explosives: No blasting or use of explosives will be allowed onsite.

PART 2 PRODUCTS

2.01 PROJECT SIGN

- A. Provide and maintain one, 8-foot-wide by 4-foot-high sign constructed of 3/4-inch exterior high density overlaid plywood. Sign shall bear name of Project, Owner, Contractor, Engineer, and other participating agencies. Lettering shall be blue applied on white background by an experienced sign painter. Include Owner's logo in full color. Provide exterior type enamel paint. Information to be included and logo graphic will be provided by Owner.

PART 3 EXECUTION

3.01 TEMPORARY UTILITIES

- A. Power:
 - 1. Electric power will be available at Site. Determine type and amount available and make arrangements for obtaining temporary electric power service, metering equipment, and pay costs for electric power used during Contract period, except for portions of the Work designated in writing by Engineer as substantially complete.
 - 2. Cost of electric power will be borne by Contractor.
- B. Water: Owner will provide a place of temporary connection for construction water at Site. Provide temporary facilities and piping required to bring water to point of use and remove when no longer needed. Install an acceptable metering device and pay for water used at Owner's current rate.
- C. Sanitary and Personnel Facilities:
 - 1. Provide and maintain facilities for Contractor's employees, Subcontractors, and other onsite employers' employees. Service, clean, and maintain facilities and enclosures.
 - 2. Use of Owner's existing sanitary facilities by construction personnel will not be allowed.

D. Telephone Service:

1. Contractor: Arrange and provide onsite telephone service for use during construction. Pay costs of installation and monthly bills.
2. No incoming calls allowed to Owner's plant telephone system.

E. Fire Protection: Furnish and maintain on Site adequate firefighting equipment capable of extinguishing incipient fires. Comply with applicable parts of NFPA 241.

3.02 PROTECTION OF WORK AND PROPERTY

A. General:

1. Maintain in continuous service existing oil gas pipelines, underground power, telephone or communication cable, water mains, irrigation lines, sewers, poles and overhead power, and other utilities encountered.
2. Protect, shore, brace, support, and maintain underground pipes, conduits, drains, and other underground utility construction uncovered or otherwise affected by construction operations.
3. Keep fire hydrants and water control valves free from obstruction and available for use at all times.
4. In areas where Contractor's operations are adjacent to or near a utility, such as gas, telephone, television, electric power, water, sewer, or irrigation system, and such operations may cause damage or inconvenience, suspend operations until arrangements necessary for protection have been made by Contractor.
5. Do not impair operation of existing sewer system. Prevent construction material, pavement, concrete, earth, volatile and corrosive wastes, and other debris from entering sewers, pump stations, or other sewer structures.
6. Maintain original Site drainage wherever possible.

B. Finished Construction: Protect finished floors and concrete floors exposed as well as those covered with composition tile or other applied surfacing.

C. Waterways: Keep ditches, culverts, and natural drainages continuously free of construction materials and debris.

3.03 TEMPORARY CONTROLS

A. Air Pollution Control:

1. Minimize air pollution from construction operations.
2. Burning of waste materials, rubbish, or other debris will not be permitted on or adjacent to Site.

- B. Noise Control: Provide acoustical barriers so noise emanating from tools or equipment will not exceed legal noise levels.
- C. Water Pollution Control:
 - 1. Divert sanitary sewage and nonstorm waste flow interfering with construction and requiring diversion to sanitary sewers. Do not cause or permit action to occur which would cause an overflow to existing waterway.
 - 2. Comply with Section 01 57 13, Temporary Erosion and Sedimentation Control, for stormwater flow and surface runoff.
 - 3. Do not dispose of volatile wastes such as mineral spirits, oil, chemicals, or paint thinner in storm or sanitary drains. Disposal of wastes into streams or waterways is prohibited. Provide acceptable containers for collection and disposal of waste materials, debris, and rubbish.
- D. Erosion, Sediment, and Flood Control: Provide, maintain, and operate temporary facilities as specified in Section 01 57 13, Temporary Erosion and Sedimentation Control, to control erosion and sediment releases, and to protect the Work and existing facilities from flooding during construction period.

3.04 STORAGE YARDS AND BUILDINGS

- A. Coordinate requirements with Section 01 61 00, Common Product Requirements.
- B. Temporary Storage Yards: Construct temporary storage yards for storage of products that are not subject to damage by weather conditions.
- C. Temporary Storage Buildings:
 - 1. Provide environmental control systems that meet recommendations of manufacturers of equipment and materials stored.
 - 2. Arrange or partition to provide security of contents and ready access for inspection and inventory.
 - 3. Store combustible materials (paints, solvents, fuels) in a well-ventilated and remote building meeting safety standards.

3.05 PARKING AREAS

- A. Control vehicular parking to preclude interference with Owner's operations or construction operations.

- B. Provide parking facilities for personnel working on Project. No employee or equipment parking will be permitted on Owner's existing paved areas.
- C. Use area designated on Drawings for parking of Contractor's and Contractor's employees' vehicles.

3.06 CLEANING DURING CONSTRUCTION

- A. In accordance with General Conditions, as may be specified in other Specification sections, and as required herein.
- B. Wet down exterior surfaces prior to sweeping to prevent blowing of dust and debris. At least weekly, sweep floors (basins, tunnels, platforms, walkways, roof surfaces), and pick up and dispose of debris.
- C. Provide approved containers for collection and disposal of waste materials, debris, and rubbish. At least weekly, dispose of such waste materials, debris, and rubbish offsite.
- D. At least weekly, brush sweep entry drive, roadways, and other streets and walkways affected by the Work and where adjacent to the Work.

END OF SECTION

SECTION 01 57 13
TEMPORARY EROSION AND SEDIMENT CONTROL

PART 1 GENERAL

1.01 WORK OF THIS SECTION

- A. This section covers work necessary for stabilization of soil to prevent erosion before, during and after construction and land disturbing activities. The work shall include the furnishing of all labor, materials, tools, and equipment to perform the work and services necessary as herein specified and as indicated on the approved Drawings. This shall include installation, maintenance, and final removal of all temporary soil erosion and sediment control measures and installation of permanent soil erosion control practices.
- B. The minimum areas requiring soil erosion and sediment control measures are indicated on the Drawings. The right is reserved to modify the use, location, and quantities of soil erosion and sediment control measures based on activities of the Contractor and as the Engineer considers to be to the best interest of the Owner.
- C. See additional information noted on the Drawings.
- D. Erosion and sediment control practices shall comply with the "Manual for Erosion and Sediment Control in Georgia," latest edition.

1.02 DEFINITIONS

- A. BMP: Best Management Practice means the schedule of activities, prohibitions of practices, maintenance procedures, and other structural or vegetative management practices to prevent or reduce the pollution of waters of the United States. BMPs also include treatment requirements, operating procedures, and practices to control site runoff, spillage or leaks, and waste disposal.
- B. Certified Contractor: A person who has received training and is a certified professional to install/construct, inspect and maintain erosion and sediment control practices.
- C. Clearing: Removal of interfering or objectionable material lying on or protruding above ground surface.

- D. ESC: Erosion and sediment control. Any temporary or permanent measures that prevent or reduce erosion, control sedimentation, and ensure that sediment does not leave a site.
- E. Land Disturbing Activity: Any activity that results in a change in the existing soil cover (both vegetative and non-vegetative) and/or the existing soil topography. Land disturbing activities include, but are not limited to demolition, construction, clearing, grading, excavation and filling.
- F. Maintenance Period: Maintenance period begins immediately after each area is planted and shall continue for a period of 8 weeks after all seeding, sodding, and planting are completed.
- G. Project Limits: Areas, as shown or specified, within which Work is to be performed.
- H. Sediments: Soil, sand, and minerals washed from land into water, usually after a rain event.
- I. Standard Specifications: When referenced in this section, shall mean the current edition of the State of Georgia, Department of Transportation, Standard Specifications for Construction of Transportation Systems. When reference is made to a specific part of the Standard Specifications, such applicable part shall be considered as part of this section of the Specifications. In case of a conflict in the requirements of the Standard Specifications and the requirements stated herein, the most stringent requirements shall prevail.

1.03 GENERAL

- A. All activities shall conform to the “Manual for Erosion and Sediment Control in Georgia,” latest edition. Fayette County permit requirements for land disturbance activities, and the Drawings. In the event of a conflict, the more stringent requirement shall apply.
- B. Land disturbance activities shall not commence until the Land Disturbance Permit has been issued.
- C. The escape of sediment from the site shall be prevented by the installation of Erosion and Sediment Control measures and practices prior to, and concurrent with land disturbing activities for the entire duration of the project.
- D. Erosion and sediment control practices shall be installed prior to commencement of land disturbance activities.

- E. Soil erosion stabilization and sedimentation control consist of, but not limited to, the following elements:
1. Conducting earthwork and excavation activities in such a manner to fit the topography soil type and condition.
 2. Implementation and continuous maintenance of BMP's.
 3. Minimize disturbed area and duration of exposure to erosion elements.
 4. Stabilize disturbed areas immediately:
 - a. Topsoil and seeding:
 - 1) Placement and maintenance of Temporary Seeding on all areas disturbed by construction.
 - 2) Placement of permanent topsoil, fertilizer, and seed, etc., in all areas not occupied by structures or pavement, unless shown otherwise.
 - b. Soil Stabilization Seeding: Placement of fertilizer and seed, etc., in areas as specified hereinafter.
 5. Maintenance of existing permanent or temporary storm drainage piping and channel systems, as necessary.
 6. Construction of new permanent and temporary storm drainage piping and channel systems, as necessary.
 7. Construction or installation of temporary erosion control facilities such as inlet sediment traps, silt fences, etc.
- F. Contractor shall install and add to the erosion control measures as determined by the Engineer, Owner, the County, or Georgia EPD.
- G. The Contractor shall be responsible for phasing Work in areas allocated for his exclusive use during this Project, including any proposed stockpile areas, to restrict sediment transport. This will include installation of any temporary erosion control devices, ditches, or other facilities.
- H. The areas set aside for the Contractor's use during the Project may be temporarily developed to provide satisfactory working, staging, and administrative areas for his exclusive use. Preparation of these areas shall be in accordance with other requirements contained within these Specifications and shall be done in a manner to both control all sediment transport away from the area.
- I. Contractor is responsible for maintaining all erosion control measures installed for the full duration of this Contract.
- J. Contractor shall observe the approved Project sequence. The Contractor shall maintain careful scheduling and performance to ensure that the exposure of land area stripped of its natural cover is kept to a minimum.

- K. Prior to commencing land disturbance activities, the Contractor shall clearly and accurately demarcate the limits of land disturbance with clearing fence or other appropriate means, for the entire duration of the Project.
- L. No land disturbance shall occur outside the approved limits indicated in the approved Drawings.
- M. After installation of the initial erosion and sediment control measures, the Contractor shall schedule an inspection with the Engineer and the County's site inspector. No other construction activities shall occur until the Engineer approves the installation of the initial erosion and sediment control measures. If unforeseen conditions exist in the field that warrants the installation of additional erosion and sediment control measures, the Contractor must install any additional measures deemed necessary by the Engineer.
- N. The location of some erosion and sediment control measures may have to be altered from those shown on the approved Drawings if drainage patterns during construction differ from the ones shown on the Drawings. Contractor is responsible to accomplish erosion and sediment control for all drainage patterns created during various stages of construction. Contractor shall report to the Engineer any difficulty in controlling erosion during any phase of construction.
- O. Mulch or temporary seeding shall be applied to all disturbed areas within 7 days of clearing. All disturbed areas that are stabilized with mulch shall be stabilized with temporary seeding after 30 days.
- P. Areas opened by construction operations and that are not anticipated to be re-excavated or dressed and received final grassing treatment within 30 days shall be temporary seeded with a quick growing grass species which will provide an early cover during the season in which it is planted and will not compete with the permanent grassing.
- Q. Earthwork operations in the vicinity of stream buffers shall be carefully controlled to avoid dumping or sloughing into the buffer.
- R. Inlet sediment protection shall be installed on all stormwater structures as they are constructed and as shown on the Drawings. Sediment shall not be washed into inlets.
- S. Upon completion of construction, the Contractor shall remove all temporary erosion control measures and dispose of them, unless noted on the Drawings.
- T. The Contractor shall maintain all elements of the Soil Erosion Stabilization and Sedimentation Control systems and facilities to be constructed during this Project for the duration of his activities on this Project until permanent stabilization of the Site is achieved.

- U. Contractor shall inspect erosion and sediment control measures each day to ensure that they are working properly. Formal inspections made jointly by the Contractor and the Engineer shall be conducted, at a minimum, every 2 weeks to evaluate the Contractor's conformance to the requirements of these Specifications, Fayette County regulations, and the Manual for Erosion and Sediment Control in Georgia.
- V. All silt traps shall be cleaned of collected sediment after every storm event, and shall be immediately repaired or replaced if found to be defective. Cleaning shall be done in a manner that will not direct the sediment into the storm drain piping system. Removed sediment shall be taken to an area selected by the Engineer where it can be cleaned of sticks and debris, then allowed to dry. Final sediment and debris disposal shall be onsite as designated by Engineer.
- W. Silt fence shall be inspected for depth of sediment, tears, to see if fabric is securely attached to the fence posts, and to see that the fence posts are firmly in the ground. Built up sediment shall be removed from silt fence when it has reached one-half the height of the fence.
- X. Sediment shall be removed from the retrofitted ponds when one-third of the sediment storage capacity has been reached.
- Y. Temporary and permanent seeding and planting shall be inspected for bare spots, washouts, and healthy growth. All the permanent seeded grass cover areas shall be reworked and reseeded if 75 percent grass cover is not achieved within 14 days.
- Z. If full implementation of the approved Drawings does not provide for effective erosion and sediment control, additional measures shall be implemented as directed by the Engineer.
- AA. Contractor's failure to install, operate and maintain all erosion and sediment control measures, to the satisfaction of the Engineer, will result in all construction being stopped on the job until such measures are installed or returned to their proper functional condition.
- BB. A maintenance inspection report shall be made after each inspection by the Contractor. The reports will be kept onsite during construction and available upon request by the Owner, the Engineer, the County, or any Federal or Local Agency approving erosion and sediment control plans. This report shall be made and retained as part of the Stormwater Pollution Prevention Plan for at least 3 years from the date that the site is finally stabilized and the Notice of Termination is submitted. The report shall identify any incidents of non-compliance.

1.04 SUBMITTALS

- A. Submittals of all Erosion Control products required for installation of proposed BMPs shall be made in accordance with Section 01 33 00, Submittal Procedures:
 - 1. Shop Drawings.
 - 2. Product Data.
 - 3. Samples.
- B. In addition, the Contractor shall provide the following specific information:
 - 1. Erosion and Sediment Control Plans identifying any field changes.
 - 2. Supporting calculations from any deviation from the approved ESC plans.
 - 3. Sequence and schedule of activities; such as ESC installation, ESC maintenance, site clearing, grading, construction activities, construction of utilities, infrastructure and buildings, final grading, and temporary and final stabilization and removal of all ESC measures.
 - 4. Schedule shall identify the expected date and duration of each activity.
 - 5. Copy of Land Disturbance Permit.

PART 2 PRODUCTS

2.01 SILT FENCE

- A. Type-C silt fence in accordance with the “Manual for Erosion and Sediment Control in Georgia,” latest edition and Section 171 of the Department of Transportation, State of Georgia, Standard Specifications, latest edition.

2.02 PERMANENT SEED

- A. As specified in Section 32 92 00, Turf and Grasses and on the “Permanent Vegetation Cover” schedule shown in the ESC plans.

2.03 TEMPORARY SEED

- A. As specified in Section 32 92 00, Turf and Grasses and on the “Temporary Vegetation Cover” schedule shown in the ESC plans.

2.04 TOPSOIL

- A. Topsoil shall be as specified under Section 32 91 13, Soil Preparation.

2.05 FERTILIZER

- A. As specified in Section 32 91 13, Soil Preparation.

2.06 LIME

- A. As specified in Section 32 91 13, Soil Preparation.

2.07 MULCH

- A. As specified in Drawings.

2.08 EROSION CONTROL MATTING

- A. As specified in Section 31 32 00, Soil Stabilization.

2.09 TACKIFIER

- A. As specified in Section 31 32 00, Soil Stabilization.

2.10 WATER FOR DUST CONTROL

- A. Free of hazardous or toxic contaminants.

PART 3 EXECUTION

3.01 GENERAL

- A. The Contractor shall install erosion and sediment control measures and maintain in accordance with the Drawings. The sequence of construction shown on the Drawings is made a part of these Contract Documents.
- B. The Contractor shall provide and maintain soil stabilization at all times.
- C. After installation of the initial erosion and sediment control measures, the Contractor shall schedule an inspection with the Engineer and the Owner's site inspector. No other construction activities shall occur until the Engineer approves the installation of the initial erosion and sediment control measures. If unforeseen conditions exist in the field that warrants the installation of additional erosion and sediment control measures, the Contractor must install any additional measures deemed necessary by the Engineer.
- D. Contractor shall observe the approved Project sequence. The Contractor shall maintain careful scheduling and performance to ensure that the exposure of land area stripped of its natural cover is kept to a minimum.
- E. Inlet sediment protection shall be installed on all existing and proposed stormdrain structures as shown on the Plans. Sediment shall not be washed into inlets.

3.02 SILT FENCE

- A. The Contractor shall construct silt fence Type-C in accordance with the “Manual for Erosion and Sediment Control in Georgia,” latest edition.

3.03 SEEDING

A. General:

1. The Contractor shall give at least 3 days’ notice to the Engineer prior to seeding to allow for inspection of the areas. The Contractor shall rework any areas not approved for seeding to the Engineer’s satisfaction.
2. The Contractor shall keep the Engineer advised of schedule of operations.
3. Seed shall be clean, delivered in original unopened packages and bearing an analysis of the contents, guaranteed 95 percent pure with minimum germination rate of 85 percent.

- B. Schedules: Seeding shall be performed in accordance with the schedules shown on the approved Drawings.

C. Soil Stabilization and Temporary Seeding:

1. Soil stabilization seeding shall consist of the application of the following materials in quantities as further described herein for stockpiles and disturbed areas left inactive for more than 14 days.
 - a. Lime.
 - b. Fertilizer.
 - c. Seed.
 - d. Mulch.
 - e. Maintenance.
2. Hydroseeding will be permitted as an alternative method of applying seed and associated soil conditioning agents described above. Should the Contractor elect to apply soil stabilization seeding by hydroseeding methods, he shall submit his operational plan and methods to the Engineer.
3. Temporary Seeding is to be placed and maintained over all disturbed areas prior to Permanent Seeding. Maintain Temporary Seeding until such time as areas are approved for Permanent Seeding. As a minimum, maintenance shall include the following:
 - a. Fix-up and reseeding of bare areas or redisturbed areas.
 - b. Mowing for stands of grass or weeds exceeding 6 inches in height.

D. Topsoil and Permanent Seeding:

1. Topsoil and Permanent Seeding shall consist of the application of the following materials in quantities as further described herein:
 - a. 4-inch depth of topsoil.
 - b. Lime.
 - c. Fertilizer.
 - d. Permanent seed mix.
 - e. Mulch.
2. Topsoil is to be placed over all disturbed areas that are not surfaced with concrete, asphalt, or pavers.
3. Preparation:
 - a. After rough grading is completed and reviewed by the Engineer, Contractor shall spread topsoil as hereinbefore specified over all areas to receive Permanent Seeding to a minimum compacted depth of 6 inches with surface elevations as shown. Loosen the finished surface to a depth of 2 inches and leave in smooth condition, free from depressions or humps, ready for seeding.
 - b. Finish Grading:
 - 1) Contractor shall rake the topsoiled area to a uniform grade, so that all areas drain as indicated on the grading plan.
 - 2) Contractor shall remove all trash and stones exceeding 1 inch in diameter from area to a depth of 2 inches.
4. Permanent Seed: After soil has been scarified, apply seed and other products at the rate and proportion specified in the "Permanent Vegetation Cover" schedule and the "Fertilizer Requirements" schedule shown on the approved Drawings.
5. Maintenance:
 - a. Maintenance Period: Contractor shall begin maintenance immediately after each portion of permanent grass is planted and continue for 8 weeks after all planting is completed.
 - b. Maintenance Operations: Contractor shall water to keep surface soil moist. Repair washed out areas by filling with topsoil, liming, fertilizing, and seeding. Replace mulch on banks when washed or blown away. Mow to 2 inches after grass reaches 3 inches in height, and mow frequently enough to keep grass from exceeding 3-1/2 inches. Weed by local spot application of selective herbicide only after first planting season when grass is established.
6. Guarantee:
 - a. If, at the end of the 8-week maintenance period, a satisfactory stand of grass has not been produced, the Contractor shall renovate and reseed the grass or unsatisfactory portions thereof immediately, or, if after October 15 during the next planting season. If a satisfactory stand of grass develops by July 1 of the following year, it will be accepted. If it is not accepted, a complete

replanting will be required during the planting season meeting all of the requirements specified under paragraph Permanent Seed.

- b. A satisfactory stand is defined as grass or section of grass that has a substantial establishment of new grass, strongly rooted, and uniformly green in appearance from a distance of 50 feet and which covers 75 percent or more of the grassed area. No noticeable thin or bare areas as determined by the Engineer.

3.04 EROSION CONTROL MATTING

- A. Shall be placed after areas have been seeded and be installed in accordance with the manufacture's recommendations, and the "Manual for Erosion and Sediment Control in Georgia," latest edition.

3.05 TACKIFIER

- A. Shall be installed in accordance with the "Manual for Erosion and Sediment Control in Georgia," latest edition and as specified in Section 31 32 00, Soil Stabilization.

3.06 DUST CONTROL

- A. Contractor shall control, at all times, surface and air movement of dust.
- B. Sprinkler site with water until the surface is wet. Repeat as needed.

3.07 STORM DRAIN INLET PROTECTION

- A. Install storm drain inlet protection around all storm drain inlets that are within 200 feet of the proposed construction to trap sediment.
- B. Filter Fabric with Supporting Frame:
 - 1. Provide silt fence with supporting frame around inlets.
 - 2. The stakes shall be spaced evenly around the perimeter of the inlet a maximum of 3 feet apart, and securely driven into the ground, approximately 18 inches deep.
 - 3. The silt fence fabric shall be entrenched 12 inches and backfilled with crushed stone or compacted soil.
 - 4. Fabric and wire shall be securely fastened to the posts, and fabric ends must be overlapped a minimum of 18 inches or wrapped together around a post to provide a continuous fabric barrier around the inlet.

C. Block and Gravel Block Inlet Protection:

1. Install concrete blocks around the perimeter of the structure. The foundation should be excavated at least 2 inches below the crest of the storm drain.
2. Place geotextile over all block openings to hold gravel in place.
3. Place clean gravel around the blocks on a 2:1 slope or flatter. Gravel should be placed 2 inches below the top of the blocks.

D. Pedestal Top Inlet Protection: Per manufacturers recommendations.

3.08 FIELD QUALITY

- A. Upon completion of maintenance period and on written notice from the Contractor, the Engineer will within 15 days of receipt, determine if a satisfactory stand has been established.
- B. If a satisfactory stand has not been established, the Engineer will make another determination upon written notice from Contractor following the next growing season.

3.09 MAINTENANCE OF EROSION AND SEDIMENT CONTROL MEASURES

- A. Erosion and sediment control measures shall be maintained at all times until permanent stabilization of the site is achieved.
- B. Erosion and sediment control measures shall be checked after each rain event, and shall be immediately repaired or replaced if found to be defective. A record shall be maintained of all inspections, repairs and replacement.
- C. Contractor shall inspect erosion and sediment control measures each day to ensure that they are working properly.
- D. Silt fence shall be inspected for depth of sediment, tears, to see if the fabric is securely attached to the fence posts, and to see that the fence posts are firmly in the ground. Build up sediment shall be removed from silt fence when it has reached on-half the height of the fence.
- E. Each BMP is to be maintained or replaced if the accumulated sediment depth is equal to or greater than one-half of the capacity of the device. Reference marks denoting the elevation at which each device is to be maintained shall be placed on all devices.

- F. Temporary and permanent seeding, sodding, and planting shall be inspected for bare spots, washouts, and healthy growth. All the permanent seeded grass cover areas shall be reworked and reseeded if 75 percent grass cover is not achieved within 14 days.
- G. If full implementation of the approved Plans does not provide for effective erosion and sediment control, additional ESC measures shall be implemented as directed by the Engineer or Owner.
- H. A maintenance inspection report shall be made after each inspection by the Contractor. The reports will be kept onsite during construction and available upon request by the Engineer, Owner, or any Federal, State, or Local Agency. The report shall identify any incidents of non-compliance.
- I. Contractor shall installed and add to erosion control measures as determined by the Engineer or the Owner.
- J. The Contractor shall maintain all elements of the ESC measures and facilities to be constructed during this Project for the duration of his activities on this Project. Formal inspections made jointly by the Contractor and the Engineer shall be conducted every 2 weeks to evaluate the Contractor's conformance to the Approved Drawings and this Specification.
- K. All silt traps shall be cleaned of collected sediment after every storm or as determined from the biweekly inspections. Cleaning shall be done in a manner that will not direct the sediment into the storm drain piping system. Removed sediment shall be taken to an area selected by the Engineer where it can be cleaned of sticks and debris, then allowed to dry. Final sediment and debris disposal shall be onsite as designated by Engineer.
- L. Replacement or repair of failed or overloaded silt fences, check dams, or other temporary erosion control devices shall be accomplished by the Contractor within 2 days after receiving written notice from the Engineer.
- M. Unpaved earth drainage ditches shall be regraded as needed to maintain original grade and remove sediment buildup. If a ditch becomes difficult to maintain, the Contractor shall cooperate with the Engineer and install additional erosion control devices such as check dams, temporary paving, or silt fences as directed by the Engineer.
- N. If the Contractor has not complied with any of the above maintenance efforts to the satisfaction of the Engineer within 2 working days after receiving written notification from the Engineer, the Owner shall have the prerogative of engaging others to perform any needed maintenance or cleanup, including removal of accumulated sediment at constructed erosion control facilities, at Contractor's expense.

END OF SECTION

SECTION 01 61 00
COMMON PRODUCT REQUIREMENTS

PART 1 GENERAL

1.01 DEFINITIONS

A. Products:

1. New items for incorporation in the Work, whether purchased by Contractor or Owner for the Project, or taken from previously purchased stock, and may also include existing materials or components required for reuse.
2. Includes the terms material, equipment, machinery, components, subsystem, system, hardware, software, and terms of similar intent and is not intended to change meaning of such other terms used in Contract Documents, as those terms are self-explanatory and have well recognized meanings in construction industry.
3. Items identified by manufacturer's product name, including make or model designation, indicated in manufacturer's published product literature, that is current as of the date of the Contract Documents.

1.02 PREPARATION FOR SHIPMENT

- A.** When practical, factory assemble products. Mark or tag separate parts and assemblies to facilitate field assembly. Cover machined and unpainted parts that may be damaged by the elements with strippable protective coating.
- B.** Package products to facilitate handling and protect from damage during shipping, handling, and storage. Mark or tag outside of each package or crate to indicate its purchase order number, bill of lading number, contents by name, name of Project and Contractor, equipment number, and approximate weight. Include complete packing list and bill of materials with each shipment.
- C.** Extra Materials, Special Tools, Test Equipment, and Expendables:
1. Furnish as required by individual Specifications.
 2. Schedule:
 - a. Ensure that shipment and delivery occurs concurrent with shipment of associated equipment.
 - b. Transfer to Owner shall occur immediately subsequent to Contractor's acceptance of equipment from Supplier.

3. Packaging and Shipment:
 - a. Package and ship extra materials and special tools to avoid damage during long term storage in original cartons insofar as possible, or in appropriately sized, hinged-cover, wood, plastic, or metal box.
 - b. Prominently displayed on each package, the following:
 - 1) Manufacturer's part nomenclature and number, consistent with Operation and Maintenance Manual identification system.
 - 2) Applicable equipment description.
 - 3) Quantity of parts in package.
 - 4) Equipment manufacturer.
 4. Deliver materials to Site.
 5. Replace extra materials and special tools found to be damaged or otherwise inoperable at time of transfer to Owner.
- D. Request a minimum 7-day advance notice of shipment from manufacturer.
- E. Factory Test Results: Reviewed and accepted by Engineer before product shipment as required in individual Specification sections.

1.03 DELIVERY AND INSPECTION

- A. Deliver products in accordance with accepted current Progress Schedule and coordinate to avoid conflict with the Work and conditions at Site. Deliver anchor bolts and templates sufficiently early to permit setting prior to placement of structural concrete.
- B. Deliver products in undamaged condition, in manufacturer's original container or packaging, with identifying labels intact and legible. Include on label, date of manufacture and shelf life, where applicable.
- C. Unload products in accordance with manufacturer's instructions for unloading or as specified. Record receipt of products at Site. Promptly inspect for completeness and evidence of damage during shipment.
- D. Remove damaged products from Site and expedite delivery of identical new undamaged products, and remedy incomplete or lost products to provide that specified, so as not to delay progress of the Work.

1.04 HANDLING, STORAGE, AND PROTECTION

- A. Handle and store products in accordance with manufacturer's written instructions and in a manner to prevent damage. Store in approved storage yards or sheds provided in accordance with Section 01 50 00, Temporary Facilities and Controls. Provide manufacturer's recommended maintenance during storage, installation, and until products are accepted for use by Owner.
- B. Manufacturer's instructions for material requiring special handling, storage, or protection shall be provided prior to delivery of material.
- C. Arrange storage in a manner to provide easy access for inspection. Make periodic inspections of stored products to ensure that products are maintained under specified conditions, and free from damage or deterioration. Keep running account of products in storage to facilitate inspection and to estimate progress payments for products delivered, but not installed in the Work.
- D. Store electrical, instrumentation, and control products, and equipment with bearings in weather-tight structures maintained above 60 degrees F. Protect electrical, instrumentation, and control products, and insulate against moisture, water, and dust damage. Connect and operate continuously space heaters furnished in electrical equipment.
- E. Store fabricated products above ground on blocking or skids, and prevent soiling or staining. Store loose granular materials in well-drained area on solid surface to prevent mixing with foreign matter. Cover products that are subject to deterioration with impervious sheet coverings; provide adequate ventilation to avoid condensation.
- F. Store finished products that are ready for installation in dry and well-ventilated areas. Do not subject to extreme changes in temperature or humidity.
- G. After installation, provide coverings to protect products from damage due to traffic and construction operations. Remove coverings when no longer needed.
- H. Hazardous Materials: Prevent contamination of personnel, storage area, and Site. Meet requirements of product specification, codes, and manufacturer's instructions.

PART 2 PRODUCTS

2.01 GENERAL

- A. Provide manufacturer's standard materials suitable for service conditions, unless otherwise specified in the individual Specifications.

- B. Where product specifications include a named manufacturer, with or without model number, and also include performance requirements, named manufacturer's products must meet the performance specifications.
- C. Like items of products furnished and installed in the Work shall be end products of one manufacturer and of the same series or family of models to achieve standardization for appearance, operation and maintenance, spare parts and replacement, manufacturer's services, and implement same or similar process instrumentation and control functions in same or similar manner.
- D. Do not use materials and equipment removed from existing premises, except as specifically permitted by Contract Documents.
- E. Provide interchangeable components of the same manufacturer, for similar components, unless otherwise specified.
- F. Equipment, Components, Systems, and Subsystems: Design and manufacture with due regard for health and safety of operation, maintenance, and accessibility, durability of parts, and shall comply with applicable OSHA, state, and local health and safety regulations.
- G. Regulatory Requirement: Coating materials shall meet federal, state, and local requirements limiting the emission of volatile organic compounds and for worker exposure.
- H. Safety Guards: Provide for all belt or chain drives, fan blades, couplings, or other moving or rotary parts. Cover rotating part on all sides. Design for easy installation and removal. Use 16-gauge or heavier; galvanized steel, aluminum coated steel, or galvanized or aluminum coated 1/2-inch mesh expanded steel. Provide galvanized steel accessories and supports, including bolts. For outdoors application, prevent entrance of rain and dripping water.
- I. Authority Having Jurisdiction (AHJ):
 - 1. Provide the Work in accordance with NFPA 70, National Electrical Code (NEC). Where required by the AHJ, material and equipment shall be labeled or listed by a nationally recognized testing laboratory or other organization acceptable to the AHJ in order to provide a basis for approval under NEC.
 - 2. Materials and equipment manufactured within the scope of standards published by Underwriters Laboratories, Inc. shall conform to those standards and shall have an applied UL listing mark.

J. Equipment Finish:

1. Provide manufacturer's standard finish and color, except where specific color is indicated.
2. If manufacturer has no standard color, provide equipment with finish as approved by Owner.

K. Special Tools and Accessories: Furnish to Owner, upon acceptance of equipment, all accessories required to place each item of equipment in full operation. These accessory items include, but are not limited to, adequate oil and grease (as required for first lubrication of equipment after field testing), light bulbs, fuses, hydrant wrenches, valve keys, handwheels, chain operators, special tools, and other spare parts as required for maintenance.

L. Lubricant: Provide initial lubricant recommended by equipment manufacturer in sufficient quantity to fill lubricant reservoirs and to replace consumption during testing, startup, and operation until final acceptance by Owner.

M. Components and Materials in Contact with Water for Human Consumption: Comply with the requirements of the Safe Drinking Water Act and other applicable federal, state, and local requirements. Provide certification by manufacturer or an accredited certification organization recognized by the Authority Having Jurisdiction that components and materials comply with the maximum lead content standard in accordance with NSF/ANSI 61 and NSF/ANSI 372.

1. Use or reuse of components and materials without a traceable certification is prohibited.

2.02 FABRICATION AND MANUFACTURE

A. General:

1. Manufacture parts to U.S.A. standard sizes and gauges.
2. Two or more items of the same type shall be identical, by the same manufacturer, and interchangeable.
3. Design structural members for anticipated shock and vibratory loads.
4. Use 1/4-inch minimum thickness for steel that will be submerged, wholly or partially, during normal operation.
5. Modify standard products as necessary to meet performance Specifications.

B. Lubrication System:

1. Require no more than weekly attention during continuous operation.
2. Convenient and accessible; oil drains with bronze or stainless steel valves and fill-plugs easily accessible from the normal operating area or platform. Locate drains to allow convenient collection of oil during oil changes without removing equipment from its installed position.
3. Provide constant-level oilers or oil level indicators for oil lubrication systems.
4. For grease type bearings, which are not easily accessible, provide and install stainless steel tubing; protect and extend tubing to convenient location with suitable grease fitting.

2.03 SOURCE QUALITY CONTROL

- A. Where Specifications call for factory testing to be witnessed by Engineer, notify Engineer not less than 14 days prior to scheduled test date, unless otherwise specified.
- B. Calibration Instruments: Bear the seal of a reputable laboratory certifying instrument has been calibrated within the previous 12 months to a standard endorsed by the National Institute of Standards and Technology (NIST).
- C. Factory Tests: Perform in accordance with accepted test procedures and document successful completion.

PART 3 EXECUTION

3.01 INSPECTION

- A. Inspect materials and equipment for signs of pitting, rust decay, or other deleterious effects of storage. Do not install material or equipment showing such effects. Remove damaged material or equipment from the Site and expedite delivery of identical new material or equipment. Delays to the Work resulting from material or equipment damage that necessitates procurement of new products will be considered delays within Contractor's control.

3.02 MANUFACTURER'S CERTIFICATE OF COMPLIANCE

- A. When so specified, a Manufacturer's Certificate of Compliance, a copy of which is attached to this section, shall be completed in full, signed by entity supplying the product, material, or service, and submitted prior to shipment of product or material or execution of the services.
- B. Engineer may permit use of certain materials or assemblies prior to sampling and testing if accompanied by accepted certification of compliance.

- C. Such form shall certify proposed product, material, or service complies with that specified. Attach supporting reference data, affidavits, and certifications as appropriate.
- D. May reflect recent or previous test results on material or product, if acceptable to Engineer.

3.03 INSTALLATION

- A. Equipment Drawings show general locations of equipment, devices, and raceway, unless specifically dimensioned.
- B. No shimming between machined surfaces is allowed.
- C. Install the Work in accordance with NECA Standard of Installation, unless otherwise specified.
- D. Repaint painted surfaces that are damaged prior to equipment acceptance.
- E. Do not cut or notch any structural member or building surface without specific approval of Engineer.
- F. Handle, install, connect, clean, condition, and adjust products in accordance with manufacturer's instructions, and as may be specified. Retain a copy of manufacturers' instruction at Site, available for review at all times.
- G. For material and equipment specifically indicated or specified to be reused in the Work:
 - 1. Use special care in removal, handling, storage, and reinstallation to assure proper function in the completed Work.
 - 2. Arrange for transportation, storage, and handling of products that require offsite storage, restoration, or renovation. Include costs for such Work in the Contract Price.

3.04 FIELD FINISHING

- A. In accordance with Section 09 90 00, Painting and Coating, and individual Specification sections.

3.05 ADJUSTMENT AND CLEANING

- A. Perform required adjustments, tests, operation checks, and other startup activities.

3.06 LUBRICANTS

- A. Fill lubricant reservoirs and replace consumption during testing, startup, and operation prior to acceptance of equipment by Owner.

3.07 SUPPLEMENTS

- A. The supplement listed below, following “End of Section”, is part of this Specification.
 - 1. Form: Manufacturer’s Certificate of Compliance.

END OF SECTION

MANUFACTURER'S CERTIFICATE OF COMPLIANCE

OWNER: _____ PRODUCT, MATERIAL, OR SERVICE
PROJECT NAME: _____ SUBMITTED: _____
PROJECT NO: _____

Comments: _____

I hereby certify that the above-referenced product, material, or service called for by the Contract for the named Project will be furnished in accordance with all applicable requirements. I further certify that the product, material, or service are of the quality specified and conform in all respects with the Contract requirements, and are in the quantity shown.

Date of Execution: _____, 20__

Manufacturer: _____

Manufacturer's Authorized Representative (*print*): _____

(Authorized Signature)

**SECTION 01 77 00
CLOSEOUT PROCEDURES**

PART 1 GENERAL

1.01 SUBMITTALS

A. Informational Submittals:

1. Submit prior to application for final payment.
 - a. Record Documents: As required in General Conditions.
 - b. Approved Shop Drawings: As required in the General Conditions.
 - c. Special bonds, Special Guarantees, and Service Agreements.
 - d. Consent of Surety to Final Payment: As required in General Conditions.
 - e. Releases or Waivers of Liens and Claims: As required in General Conditions.
 - f. Releases from Agreements.
 - g. Final Application for Payment: Submit in accordance with procedures and requirements stated in Section 01 29 00, Payment Procedures.
 - h. Extra Materials: As required by individual Specification sections.

1.02 RECORD DOCUMENTS

A. Quality Assurance:

1. Furnish qualified and experienced person, whose duty and responsibility shall be to maintain record documents.
2. Accuracy of Records:
 - a. Coordinate changes within record documents, making legible and accurate entries on each sheet of Drawings and other documents where such entry is required to show change.
 - b. Purpose of Project record documents is to document factual information regarding aspects of the Work, both concealed and visible, to enable future modification of the Work to proceed without lengthy and expensive Site measurement, investigation, and examination.
3. Make entries within 24 hours after receipt of information that a change in the Work has occurred.
4. Prior to submitting each request for progress payment, request Engineer's review and approval of current status of record documents. Failure to properly maintain, update, and submit record documents may result in a deferral by Engineer to recommend whole or any part of Contractor's Application for Payment, either partial or final.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 MAINTENANCE OF RECORD DOCUMENTS

A. General:

1. Promptly following commencement of Contract Times, secure from Engineer at no cost to Contractor, one complete set of Contract Documents as indicated in Paragraph 2.02.A of the Supplementary Conditions. Drawings will be full size.
2. Label or stamp each record document with title, "RECORD DOCUMENTS," in neat large printed letters.
3. Record information concurrently with construction progress and within 24 hours after receipt of information that change has occurred. Do not cover or conceal Work until required information is recorded.

B. Preservation:

1. Maintain documents in a clean, dry, legible condition and in good order. Do not use record documents for construction purposes.
2. Make documents and Samples available at all times for observation by Engineer.

C. Making Entries on Drawings:

1. Using an erasable colored pencil (not ink or indelible pencil), clearly describe change by graphic line and note as required.
 - a. Color Coding:
 - 1) Green when showing information deleted from Drawings.
 - 2) Red when showing information added to Drawings.
 - 3) Blue and circled in blue to show notes.
2. Date entries.
3. Call attention to entry by "cloud" drawn around area or areas affected.
4. Legibly mark to record actual changes made during construction, including, but not limited to:
 - a. Depths of various elements of foundation in relation to finished first floor data if not shown or where depth differs from that shown.
 - b. Horizontal and vertical locations of existing and new Underground Facilities and appurtenances, and other underground structures, equipment, or Work. Reference to at least two measurements to permanent surface improvements.

- c. Location of internal utilities and appurtenances concealed in the construction referenced to visible and accessible features of the structure.
 - d. Locate existing facilities, piping, equipment, and items critical to the interface between existing physical conditions or construction and new construction.
 - e. Changes made by Field Orders, Work Change Directive, Change Order, and Engineer's written interpretation and clarification using consistent symbols for each and showing appropriate document tracking number.
5. Dimensions on Schematic Layouts: Show on record drawings, by dimension, the centerline of each run of items such as are described in previous subparagraph above.
- a. Clearly identify the item by accurate note such as "cast iron drain," "galv. water," and the like.
 - b. Show, by symbol or note, vertical location of item ("under slab," "in ceiling plenum," "exposed," and the like).
 - c. Make identification so descriptive that it may be related reliably to Specifications.

3.02 FINAL CLEANING

- A. At completion of the Work or of a part thereof and immediately prior to Contractor's request for certificate of Substantial Completion; or if no certificate is issued, immediately prior to Contractor's notice of completion, clean entire Site or parts thereof, as applicable.
- 1. Leave the Work and adjacent areas affected in a cleaned condition satisfactory to Owner and Engineer.
 - 2. Remove grease, dirt, dust, paint or plaster splatter, stains, labels, fingerprints, and other foreign materials from exposed surfaces.
 - 3. Repair, patch, and touch up marred surfaces to specified finish and match adjacent surfaces.
 - 4. Clean all windows.
 - 5. Broom clean exterior paved driveways and parking areas.
 - 6. Hose clean sidewalks, loading areas, and others contiguous with principal structures.
 - 7. Rake clean all other surfaces.
 - 8. Leave water courses, gutters, and ditches open and clean.
- B. Use only cleaning materials recommended by manufacturer of surfaces to be cleaned.

END OF SECTION

SECTION 01 78 23
OPERATION AND MAINTENANCE DATA

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Detailed information for the preparation, submission, and Engineer's review of Operations and Maintenance (O&M) Data, as required by individual Specification sections.

1.02 DEFINITIONS

- A. Preliminary Data: Initial and subsequent submissions for Engineer's review.
- B. Final Data: Engineer-accepted data, submitted as specified herein.
- C. Maintenance Operation: As used on Maintenance Summary Form is defined to mean any routine operation required to ensure satisfactory performance and longevity of equipment. Examples of typical maintenance operations are lubrication, belt tensioning, adjustment of pump packing glands, and routine adjustments.

1.03 SEQUENCING AND SCHEDULING

- A. Equipment and System Data:
 - 1. Preliminary Data:
 - a. Do not submit until Shop Drawing for equipment or system has been reviewed and approved by Engineer.
 - b. Submit prior to shipment date.
 - 2. Final Data: Submit Instructional Manual Formatted data and Electronic Media Formatted data not less than 30 days prior to equipment or system field functional testing.

1.04 DATA FORMAT

- A. Prepare preliminary data on electronic media. Prepare final data in both the form of an instructional manual and on electronic media.
- B. Instructional Manual Format:
 - 1. Binder: Commercial quality, permanent, three-ring or three-post binders with durable plastic cover.
 - 2. Size: 8-1/2 inches by 11 inches, minimum.

3. Cover: Identify manual with typed or printed title "OPERATION AND MAINTENANCE DATA" and list:
 - a. Project title.
 - b. Designate applicable system, equipment, material, or finish.
 - c. Identity of separate structure as applicable.
 - d. Identify volume number if more than one volume.
 - e. Identity of equipment number and Specification section.
4. Spine:
 - a. Project title.
 - b. Identify volume number if more than one volume.
5. Title Page:
 - a. Contractor name, address, and telephone number.
 - b. Subcontractor, Supplier, installer, or maintenance contractor's name, address, and telephone number, as appropriate.
 - 1) Identify area of responsibility of each.
 - 2) Provide name and telephone number of local source of supply for parts and replacement.
6. Table of Contents:
 - a. Neatly typewritten and arranged in systematic order with consecutive page numbers.
 - b. Identify each product by product name and other identifying numbers or symbols as set forth in Contract Documents.
7. Paper: 20-pound minimum, white for typed pages.
8. Text: Manufacturer's printed data, or neatly typewritten.
9. Three-hole punch data for binding and composition; arrange printing so that punched holes do not obliterate data.
10. Material shall be suitable for reproduction, with quality equal to original. Photocopying of material will be acceptable, except for material containing photographs.

C. Electronic Media Format:

1. Portable Document Format (PDF): As specified in Section 01 33 00, Submittal Procedures, for electronic submittals.
 - a. After all preliminary data has been found to be acceptable to Engineer, submit final Operation and Maintenance data in PDF format on CD.
 - b. Files for final Operation and Maintenance data to be exact duplicates of Engineer-accepted preliminary data.
 - c. Files to be fully functional and viewable in most recent version of Adobe Acrobat.

1.05 SUBMITTALS

A. Informational:

1. Preliminary Data: Submission and distribution shall be as described in Section 01 33 00, Submittal Procedures.
2. Final Data: Submit two copies in instructional manual format specified herein plus one electronic copy.

1.06 DATA FOR EQUIPMENT AND SYSTEMS

A. Content For Each Unit (or Common Units) and System:

1. Product Data:
 - a. Include only those sheets that are pertinent to specific product.
 - b. Clearly annotate each sheet to:
 - 1) Identify specific product or part installed.
 - 2) Identify data applicable to installation.
 - 3) Delete references to inapplicable information.
 - c. Function, normal operating characteristics, and limiting conditions.
 - d. Performance curves, engineering data, nameplate data, and tests.
 - e. Complete nomenclature and commercial number of replaceable parts.
 - f. Original manufacturer's parts list, illustrations, detailed assembly drawings showing each part with part numbers and sequentially numbered parts list, and diagrams required for maintenance.
 - g. Spare parts ordering instructions.
 - h. Where applicable, identify installed spares and other provisions for future work (e.g., reserved panel space, unused components, wiring, terminals).
2. As-installed, color-coded piping diagrams.
3. Charts of valve tag numbers, with the location and function of each valve.
4. Drawings: Supplement product data with Drawings as necessary to clearly illustrate:
 - a. Relations of component parts of equipment and systems.
 - b. Control and flow diagrams.
 - c. Coordinate drawings with Project record documents to assure correct illustration of completed installation.
5. Instructions and Procedures: Within text, as required to supplement product data.
 - a. Format:
 - 1) Organize in consistent format under separate heading for each different procedure.
 - 2) Provide logical sequence of instructions for each procedure.

- 3) Provide information sheet for Owner's personnel, including:
 - a) Proper procedures in event of failure.
 - b) Instances that might affect validity of guarantee or Bond.
- b. Installation Instructions: Including alignment, adjusting, calibrating, and checking.
- c. Operating Procedures:
 - 1) Startup, break-in, routine, and normal operating instructions.
 - 2) Test procedures and results of factory tests where required.
 - 3) Regulation, control, stopping, and emergency instructions.
 - 4) Description of operation sequence by control manufacturer.
 - 5) Shutdown instructions for both short and extended duration.
 - 6) Summer and winter operating instructions, as applicable.
 - 7) Safety precautions.
 - 8) Special operating instructions.
- d. Maintenance and Overhaul Procedures:
 - 1) Routine maintenance.
 - 2) Guide to troubleshooting.
 - 3) Disassembly, removal, repair, reinstallation, and re-assembly.
6. Guarantee, Bond, and Service Agreement: In accordance with Section 01 77 00, Closeout Procedures.

B. Content for Each Electric or Electronic Item or System:

1. Description of Unit and Component Parts:
 - a. Function, normal operating characteristics, and limiting conditions.
 - b. Performance curves, engineering data, nameplate data, and tests.
 - c. Complete nomenclature and commercial number of replaceable parts.
 - d. Interconnection wiring diagrams, including control and lighting systems.
2. Circuit Directories of Panelboards:
3. Electrical service.
4. Control requirements and interfaces.
5. Communication requirements and interfaces.
6. List of electrical relay settings, and control and alarm contact settings.
7. Electrical interconnection wiring diagram, including as applicable, single-line, three-line, schematic and internal wiring, and external interconnection wiring.
8. As-installed control diagrams by control manufacturer.
9. Operating Procedures:
 - a. Routine and normal operating instructions.
 - b. Startup and shutdown sequences, normal and emergency.

- c. Safety precautions.
 - d. Special operating instructions.
 - 10. Maintenance Procedures:
 - a. Routine maintenance.
 - b. Guide to troubleshooting.
 - c. Adjustment and checking.
 - d. List of relay settings, control and alarm contact settings.
 - 11. Manufacturer's printed operating and maintenance instructions.
 - 12. List of original manufacturer's spare parts, manufacturer's current prices, and recommended quantities to be maintained in storage.
- C. Maintenance Summary:
- 1. Compile individual Maintenance Summary for each applicable equipment item, respective unit or system, and for components or sub-units.
 - 2. Format:
 - a. Use Maintenance Summary Form bound with this section or electronic facsimile of such.
 - b. Each Maintenance Summary may take as many pages as required.
 - c. Use only 8-1/2-inch by 11-inch size paper.
 - d. Complete using typewriter or electronic printing.
 - 3. Include detailed lubrication instructions and diagrams showing points to be greased or oiled; recommend type, grade, and temperature range of lubricants and frequency of lubrication.
 - 4. Recommended Spare Parts:
 - a. Data to be consistent with manufacturer's Bill of Materials/Parts List furnished in O&M manuals.
 - b. "Unit" is the unit of measure for ordering the part.
 - c. "Quantity" is the number of units recommended.
 - d. "Unit Cost" is the current purchase price.

1.07 SUPPLEMENTS

- A. The supplements listed below, following "End of Section", are part of this Specification.
 - 1. Forms: Maintenance Summary Form.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

MAINTENANCE SUMMARY FORM

PROJECT: _____ CONTRACT NO.: _____

1. EQUIPMENT ITEM _____

2. MANUFACTURER _____

3. EQUIPMENT/TAG NUMBER(S) _____

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

5. NAMEPLATE DATA (hp, voltage, speed, etc.) _____

6. MANUFACTURER'S LOCAL REPRESENTATIVE _____

a. Name _____ Telephone No. _____

b. Address _____

7. MAINTENANCE REQUIREMENTS

Maintenance Operation Comments	Frequency	Lubricant (If Applicable)
List briefly each maintenance operation required and refer to specific information in manufacturer's standard maintenance manual, if applicable. (Reference to manufacturer's catalog or sales literature is not acceptable.)	List required frequency of each maintenance operation.	Refer by symbol to lubricant required.

8. LUBRICANT LIST

Reference Symbol	Shell	Exxon Mobile	Chevron Texaco	BP Amoco	Or Equal
List symbols used in No. 7 above.	List equivalent lubricants, as distributed by each manufacturer for the specific use recommended.				

9. RECOMMENDED SPARE PARTS FOR OWNER'S INVENTORY.

Part No.	Description	Unit	Quantity	Unit Cost
Note: Identify parts provided by this Contract with two asterisks.				

SECTION 01 88 15 ANCHORAGE AND BRACING

PART 1 GENERAL

1.01 SUMMARY

- A. This section covers requirements for anchorage and bracing of equipment, distribution systems, and other nonstructural components required in accordance with the ICC 2012 International Building Code (IBC), for seismic, wind, gravity, soil, and operational loads.

1.02 REFERENCES

- A. The following is a list of standards which may be referenced in this section:
 - 1. American Institute of Steel Construction (AISC) 360, Specification for Structural Steel Buildings.
 - 2. American Society of Civil Engineers (ASCE): ASCE 7, Minimum Design Loads for Buildings and Other Structures.
 - 3. International Code Council (ICC): International Building Code (IBC).

1.03 DEFINITIONS

- A. Authority Having Jurisdiction (AHJ): Permitting building agency; may be a federal, state, local, or other regional department, or individual including building official, fire chief, fire marshal, chief of a fire prevention bureau, labor department, or health department, electrical inspector; or others having statutory authority. AHJ may be Owner when authorized to be self-permitting by governmental permitting agency or when no governmental agency has authority.
- B. Designated Seismic System: Architectural, electrical, and mechanical system or their components for which component importance factor is greater than 1.0.

1.04 DESIGN AND PERFORMANCE REQUIREMENTS

- A. General:
 - 1. Anchorage and bracing systems shall be designed by a qualified professional engineer registered in the State of Georgia.

2. Design anchorage into concrete including embedment in accordance with ACI 318-11, Appendix D (or other industry standard approved by Engineer), and Project Specifications.
 - a. Unless otherwise noted, design for cracked concrete condition.
3. Design anchorage and bracing of architectural, mechanical, and electrical components and systems in accordance with this section, unless a design is specifically provided within Contract Documents or where exempted hereinafter.
4. Design attachments, braces, and anchors for equipment, components, and distribution systems to structure for gravity, seismic, wind, and operational loading.
5. Anchor and brace piping and ductwork, whether exempt or not exempt for this section, so that lateral or vertical displacement does not result in damage or failure to essential architectural, mechanical, or electrical equipment.
6. Architectural Components: Includes, but are not limited to, nonstructural walls and elements, partitions, cladding and veneer, access flooring, signs, cabinets, suspended ceilings, and glass in glazed curtain walls and partitions.
7. Provide supplementary framing where required to transfer anchorage and bracing loads to structure.
8. Adjust equipment pad sizes or provide additional anchorage confinement reinforcing to provide required anchorage capacities.
9. Design anchorage and bracing for:
 - a. Equipment and components that weigh more than 400 pounds and have center of mass located 4 feet or less above adjacent finished floor.
 - b. Equipment weighing more than 20 pounds that has center of mass located more than 4 feet above adjacent finished floor.
 - c. Mechanical and electrical components that are not provided with flexible connections between components and associated ductwork, piping, or conduit.
 - d. Distribution systems that weigh more than 5 pounds per foot that have center of mass located more than 4 feet above adjacent finished floor.
10. Design seismic anchorage and bracing for Designated Seismic Systems regardless of weight or mounting height.
 - a. Component Important Factor:
 - 1) $I_p = 1.0$, unless noted otherwise.
 - 2) I_p shall be taken as 1.5 if any of the following conditions apply:
 - a) Component is required to function for life-safety purposes after an earthquake, including fire protection sprinkler systems and egress stairways.

- b) Component contains hazardous materials.
 - c) Component is in or attached to Risk Category IV structure and is needed for continued operation of facility or its failure could impair continued operation of facility.
- 3) Refer to Section 01 45 36, Equipment Seismic Certification, for list of designated components which I_p equals 1.5.
- 11. For components exempted from design requirements of this section, provide bolted, welded, or otherwise positively fastened attachments to supporting structure.

B. Design Loads:

- 1. Gravity: Design anchorage and bracing for self-weight and superimposed loads on components and equipment.
- 2. Wind: Design anchorage and bracing for wind criteria provided on General Structural Notes on Drawings for exposed architectural components and exterior and wind-exposed mechanical and electrical equipment. Alternately, manufacturer certification may be provided for components such as roofing and flashing to verify attachments meet Project-specific design criteria.
- 3. Operational:
 - a. For loading supplied by equipment manufacturer for IBC required load cases.
 - b. Loads may include equipment vibration, torque, thermal effects, effects of internal contents (weight and sloshing), water hammer, and other load-inducing conditions.
 - c. Locate braces to minimize vibration to or movement of structure.
 - d. For vibrating loads, use anchors meeting requirements of Section 05 50 00, Metal Fabrications or Section 05 05 19, Post-Installed Anchors, for anchors with designated capacities for vibratory loading per manufacturer's ICC-ES report.
- 4. Seismic:
 - a. In accordance with 2012 IBC, Section 1613, and Chapter 13 of ASCE 7.
 - b. Design anchorage and bracing for design criteria listed on General Structural Notes on Drawings.
 - c. Design forces for anchors in concrete or masonry shall be in accordance with ASCE 7, Section 13.4.2 IBC Section 1905.1.9 as applicable for Project Seismic Design Category.

C. Seismic Design Requirements:

1. Nonstructural Components: Design as nonbuilding structures for components with weights greater than or equal to 25 percent of effective seismic weight of overall structure.
2. Analyze local region of body of nonstructural component for load transfer of anchorage attachment if component $I_p = 1.5$.
3. The following are exempt from requirements for provision of seismic anchorages and bracing, in addition to those items specifically exempted in ASCE 7, Part 13.5 for architectural components and Part 13.6 for electrical and mechanical equipment:
 - a. Furniture, except storage cabinets and bookshelves over 6 feet tall.
 - b. Temporary or movable equipment.
4. Fire protection sprinkler systems designed and constructed in accordance with NFPA 13 shall be considered to meet requirements of Chapter 13 of ASCE 7.
5. Provide support drawings and calculations for electrical distribution components if any of the following conditions apply:
 - a. Conduit diameter is greater than 2.5-inch trade size.
 - b. Total weight of bus duct, cable tray, or conduit supported by trapeze assemblies exceeds 10 pounds per foot.
6. Other seismic design and detailing information identified in ASCE 7, Chapter 13, is required to be provided for new and modified or noted architectural, mechanical and electrical components, systems, or equipment.

1.05 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
 - a. List of architectural, mechanical, and electrical equipment requiring Contractor-designed anchorage and bracing, unless specifically exempted.
 - b. Manufacturers' engineered seismic and non-seismic hardware product data.
 - c. Attachment assemblies' drawings including seismic attachments; include connection hardware, braces, and anchors or anchor bolts for nonexempt components, equipment, and systems.

- d. Drawings for seismic attachment assemblies include connection hardware, braces, and anchors (or anchor bolts) for modified, nonexempt existing components, equipment, and systems where a combination of new and existing systems or components' final condition would require anchorage or bracing under this specification for new equipment.
- e. Submittal will be rejected if proposed anchorage method would create excessive stress to supporting member. Revise anchorages and strengthen structural support to eliminate overstressed condition.

B. Informational Submittals:

- 1. Anchorage and Bracing Calculations: For attachments, braces, and anchorages, include IBC and Project-specific criteria as noted on General Structural Notes on Drawings, in addition to manufacturer's specific criteria used for design; sealed by a civil engineer registered in the State of Georgia.
- 2. Manufacturer's hardware installation requirements.

C. Deferred Submittals:

- 1. Submitted seismic anchorage drawings and calculations for Designated Seismic Systems are identified as IBC deferred submittals and will be submitted to and must be accepted by AHJ prior to installation of component, equipment, or distribution system.
- 2. Submit deferred Action Submittals such as Shop Drawings with supporting deferred informational submittals such as calculations no less than 4 weeks in advance of installation of component, equipment or distribution system to be anchored to structure.

1.06 SOURCE QUALITY CONTROL

- A. Contractor and supplier responsibilities to accommodate Owner-furnished shop fabrication related special inspections and testing are provided in Project's Statement of Special Inspections in Supplement located at the end of Section 01 45 33, Special Inspection, Observation, and Testing.
- B. Provide all other specified, regulatory required, or required repair verification inspection and testing that is not listed in Statement of Special Inspections in accordance with Section 01 45 16.13, Contractor Quality Control.
- C. Provide Source Quality Control for welding and hot-dip galvanizing of anchors in accordance with Section 05 50 00, Metal Fabrications.

PART 2 PRODUCTS

2.01 GENERAL

- A. Design and construct attachments and supports transferring seismic and non-seismic loads to structure of materials and products suitable for application and in accordance with design criteria shown on Drawings and nationally recognized standards.
- B. Provide anchor bolts for anchorage of equipment to concrete or masonry in accordance with Section 05 50 00, Metal Fabrications. Provide anchor bolts of the size, minimum embedment, and spacing designated in calculations submitted by Contractor and accepted by Engineer.
- C. Provide post-installed concrete and masonry anchors for anchorage of equipment to concrete or masonry in accordance with Section 05 05 19, Post-Installed Anchors. Provide post-installed anchors of the size, minimum embedment, and spacing designated in calculations submitted by Contractor and accepted by Engineer.
- D. Do not use powder-actuated fasteners or sleeve anchors for seismic attachments and anchorage where resistance to tension loads is required. Do not use expansion anchors, other than undercut anchors, for nonvibration isolated mechanical equipment rated over 10 horsepower.

PART 3 EXECUTION

3.01 GENERAL

- A. Make attachments, bracing, and anchorage in such a manner that component lateral force is transferred to lateral force resisting system of structure through a complete load path.
- B. Design, provide, and install overall seismic anchorage system to provide restraint in all directions, including vertical, for each component or system so anchored.
- C. Provide snubbers in each horizontal direction and vertical restraints for components mounted on vibration isolation systems where required to resist overturning.

- D. Provide piping anchorage that maintains design flexibility and expansion capabilities at flexible connections and expansion joints.
 - 1. Piping and ductwork suspended more than 12 inches below supporting structure shall be braced for seismic effects to avoid significant bending of hangers and their attachments unless high-deformability piping is used per ASCE 7, Section 13.6.8 or HVAC ducts have a cross-sectional area of less than 6 square feet or weigh 17 pounds per foot or less.
- E. Anchor tall and narrow equipment such as motor control centers and telemetry equipment at base and within 12 inches from top of equipment, unless approved otherwise by Engineer.
- F. Do not attach architectural, mechanical, or electrical components to more than one element of a building structure at a single restraint location where such elements may respond differently during a seismic event. Do not make such attachments across building expansion and contraction joints.

3.02 INSTALLATION

- A. Do not install components or their anchorages or restraints prior to review and acceptance by Engineer and AHJ.
- B. Notify Engineer upon completion of installation of seismic restraints in accordance with Section 01 45 33, Special Inspection, Observation, and Testing.

3.03 FIELD QUALITY ASSURANCE AND QUALITY CONTROL

- A. In accordance with Section 05 50 00, Metal Fabrications and Section 05 05 19, Post-Installed Anchors.
- B. Owner-Furnished Quality Assurance, in accordance with IBC Chapter 17 requirements, is provided in Statement of Special Inspections Plan in Supplement located at end of Section 01 45 33, Special Inspection, Observation, and Testing. Contractor responsibilities and related information are included in Section 01 45 33, Special Inspection, Observation, and Testing.
- C. Provide any other specified, regulatory required, or required repair verification inspection and testing that is not listed in Statement of Special Inspections in accordance with Section 01 45 16.13, Contractor Quality Control.

END OF SECTION

SECTION 01 91 14
EQUIPMENT TESTING AND STARTUP

PART 1 GENERAL

1.01 DEFINITIONS

- A. Functional Test: Test or tests in presence of Engineer and Owner to demonstrate that installed equipment meets manufacturer's installation, calibration, and adjustment requirements and other requirements as specified.
- B. Performance Test: Test or tests performed after any required functional test in presence of Engineer and Owner to demonstrate and confirm individual equipment meets performance requirements specified in individual sections.
- C. Unit Process: As used in this section, a unit process is a portion of the facility that performs a specific process function, such as the chlorine dioxide generation system.
- D. Performance Demonstration: A demonstration, conducted by Contractor, with assistance of Owner, to demonstrate and document the performance of the chlorine dioxide generation system, both manually and automatically (if required), based on criteria developed in conjunction with Owner and as accepted by Engineer.

1.02 SUBMITTALS

- A. Informational Submittals:
 - 1. Functional and performance test results.
 - 2. Completed Unit Process Startup Form for each unit process.

1.03 STARTUP AND PERFORMANCE DEMONSTRATION PLAN

- A. Develop a written plan, in conjunction with Owner's operations personnel; to include the following:
 - 1. Step-by-step instructions for startup of the process.
 - 2. Unit Process Startup Form (sample attached), to minimally include the following:
 - a. Description of the unit process, including equipment numbers/nomenclature of each item of equipment and all included devices.
 - b. Detailed procedure for startup of the unit process, including valves to be opened/closed, order of equipment startup, etc.

- c. Startup requirements for each unit process, including water, power, chemicals, etc.
- d. Space for evaluation comments.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 GENERAL

- A. Startup Meetings: Schedule, in accordance with requirements of Section 01 31 19, Project Meetings, to discuss test schedule, test methods, materials, chemicals and liquids required, facilities operations interface, and Owner involvement.
- B. Contractor's Testing and Startup Representative:
 - 1. Designate and furnish one or more personnel to coordinate and expedite testing and startup.
 - 2. Representative(s) shall be present during startup meetings and shall be available at all times during testing and startup.
- C. Provide temporary valves, gauges, piping, test equipment and other materials and equipment required for testing and startup.
- D. Provide Subcontractor and equipment manufacturers' staff adequate to prevent delays. Schedule ongoing work so as not to interfere with or delay testing and startup.
- E. Owner will:
 - 1. Provide water, power, chemicals, and other items as required for startup, unless otherwise indicated.
 - 2. Operate process units and facility with support of Contractor.
 - 3. Provide labor and materials as required for laboratory analyses.

3.02 EQUIPMENT TESTING

- A. Preparation:
 - 1. Complete installation before testing.
 - 2. Furnish qualified manufacturers' representatives, when required by individual Specification sections.
 - 3. Obtain and submit from equipment manufacturer's representative Manufacturer's Certificate of Proper Installation Form, in accordance with Section 01 43 33, Manufacturers' Field Services, when required by individual Specification sections.

4. Equipment Test Report Form: Provide written test report for each item of equipment to be tested, to include the minimum information:
 - a. Owner/Project Name.
 - b. Equipment or item tested.
 - c. Date and time of test.
 - d. Type of test performed (Functional or Performance).
 - e. Test method.
 - f. Test conditions.
 - g. Test results.
 - h. Signature spaces for Contractor and Engineer as witness.
5. Cleaning and Checking: Prior to beginning functional testing:
 - a. Calibrate testing equipment in accordance with manufacturer's instructions.
 - b. Inspect and clean equipment, devices, connected piping, and structures to ensure they are free of foreign material.
 - c. Lubricate equipment in accordance with manufacturer's instructions.
 - d. Turn rotating equipment by hand when possible to confirm that equipment is not bound.
 - e. Open and close valves by hand and operate other devices to check for binding, interference, or improper functioning.
 - f. Check power supply to electric-powered equipment for correct voltage.
 - g. Adjust clearances and torque.
 - h. Test piping for leaks.
6. Ready-to-test determination will be by Engineer based at least on the following:
 - a. Acceptable Operation and Maintenance Data.
 - b. Notification by Contractor of equipment readiness for testing.
 - c. Receipt of Manufacturer's Certificate of Proper Installation, if so specified.
 - d. Adequate completion of work adjacent to, or interfacing with, equipment to be tested.
 - e. Availability and acceptability of manufacturer's representative, when specified, to assist in testing of respective equipment.
 - f. Satisfactory fulfillment of other specified manufacturer's responsibilities.
 - g. Equipment and electrical tagging complete.
 - h. Delivery of all spare parts and special tools.

B. Functional Testing:

1. Conduct as specified in individual Specification sections.
2. Notify Owner and Engineer in writing at least 10 days prior to scheduled date of testing.

3. Prepare Equipment Test Report summarizing test method and results.
4. When, in Engineer's opinion, equipment meets functional requirements specified, such equipment will be accepted for purposes of advancing to performance testing phase, if so required by individual Specification sections. Such acceptance will be evidenced by Engineer/Owner's signature as witness on Equipment Test Report.

C. Performance Testing:

1. Conduct as specified in individual Specification sections.
2. Notify Engineer and Owner in writing at least 10 days prior to scheduled date of test.
3. Performance testing shall not commence until equipment has been accepted by Engineer as having satisfied functional test requirements specified.
4. Type of fluid, gas, or solid for testing shall be as specified.
5. Unless otherwise indicated, furnish labor, materials, and supplies for conducting the test and taking samples and performance measurements.
6. Prepare Equipment Test Report summarizing test method and results.
7. When, in Engineer's opinion, equipment meets performance requirements specified, such equipment will be accepted as to conforming to Contract requirements. Such acceptance will be evidenced by Engineer's signature on Equipment Test Report.

3.03 STARTUP OF UNIT PROCESSES

- A. Prior to unit process startup, equipment within unit process shall be accepted by Engineer as having met functional and performance testing requirements specified.
- B. Make adjustments, repairs, and corrections necessary to complete unit process startup.
- C. Startup shall be considered complete when, in opinion of Engineer, unit process has operated in manner intended for 5 continuous days without significant interruption. This period is in addition to functional or performance test periods specified elsewhere.
- D. Significant Interruption: May include any of the following events:
 1. Failure of Contractor to provide and maintain qualified onsite startup personnel as scheduled.
 2. Failure to meet specified functional operation for more than 2 consecutive hours.
 3. Failure of any critical equipment or unit process that is not satisfactorily corrected within 5 hours after failure.

- 4. Failure of any noncritical equipment or unit process that is not satisfactorily corrected within 8 hours after failure.
- 5. As determined by Engineer.
- E. A significant interruption will require startup then in progress to be stopped. After corrections are made, startup test period to start from beginning again.

3.04 PERFORMANCE DEMONSTRATION

- A. Demonstrate proper operation of required interfaces within and between individual unit processes.
- B. Document, as defined in Startup and Performance Demonstration Plan, the performance including interface with plant's computer system.

3.05 SUPPLEMENTS

- A. Supplements listed below, following "End of Section," are a part of this Specification:
 - 1. Unit Process Startup Form.

END OF SECTION

UNIT PROCESS STARTUP FORM

OWNER:_____ **PROJECT:**_____

Unit Process Description: (Include description and equipment number of all equipment and devices):

Startup Procedure (Describe procedure for sequential startup and evaluation, including valves to be opened/closed, order of equipment startup, etc.):

Startup Requirements (Water, power, chemicals, etc.):_____

Evaluation Comments:_____

**SECTION 02 41 00
DEMOLITION**

PART 1 GENERAL

1.01 DEFINITIONS

- A. Demolition: Dismantling, razing, destroying, or wrecking of any fixed building or structure or any part thereof. Demolition also includes removal of pipes, manholes tanks, conduit, and other underground facilities, whether as a separate activity or in conjunction with construction of new facilities.
- B. Modify: Provide all necessary material and labor to modify an existing item to the condition indicated or specified.
- C. Relocate: Remove, protect, clean and reinstall equipment, including electrical, instrumentation, and all ancillary components required to make the equipment fully functional, to the new location identified on the Drawings.
- D. Renovation: Altering a facility or one or more facility components in any way.
- E. Salvage/Salvageable: Remove and deliver, to the specified location(s), the equipment, building materials, or other items so identified to be saved from destruction, damage, or waste; such property to remain that of Owner. Unless otherwise specified, title to items identified for demolition shall revert to Contractor.

1.02 SEQUENCING AND SCHEDULING

- A. Include the Work of this Specification in the progress schedule, as specified in Section 01 32 00, Construction Progress Documentation.
- B. Areas in which the Work is to be accomplished will be available in accordance with the following schedule:
 - 1. Demolition of the existing electrical equipment and chlorine dioxide generation system shall not commence until the new chlorine dioxide generation system is fully operational.
 - 2. The existing Accuflow feed pump and associated controller may be removed to facilitate installation of the new equipment and piping. The existing peristaltic feed pump is to remain in service until the new generation system is fully operational. Removal of the Accuflow pump and controller shall be coordinated with plant staff.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

A. Utilities and Related Equipment:

1. Remove existing utilities as indicated and terminate in a manner conforming to the nationally recognized code covering the specific utility and approved by Engineer.
2. When utility lines are encountered that are not indicated on the Drawings, notify Engineer prior to further work in that area.
3. Remove meters and related equipment and deliver to a location as determined by the Engineer.

B. Concrete:

1. Core drill corners of new opening to avoid overcutting adjacent reinforcing in existing concrete to remain. Saw concrete along straight lines to a depth of not less than 2 inches. Make each cut in walls perpendicular to the face and in alignment with the cut in the opposite face. Break out the remainder of the concrete provided that the broken area is concealed in the finished Work, and the remaining concrete is sound.
2. At locations where the broken face cannot be concealed, grind smooth or saw cut entirely through the concrete. Repair exposed rebar ends and embeds as shown on Drawings.
3. Where new concrete adjoins existing concrete, thoroughly clean and mechanically roughen existing concrete surfaces to roughness profile of 3/16 inch. Rebar and small embeds at existing concrete may be required to be left to engage new concrete. Saturate surface with water for 24 hours prior to placing new concrete. The new Work shall tie into the existing construction as shown on Drawings.

C. Patching:

1. Where removals leave holes and damaged surfaces exposed in the finished Work, patch and repair to match adjacent finished surfaces as to texture and finish.
2. Where new Work is to be applied to existing surfaces, perform removals and patching in a manner to produce surfaces suitable for receiving new Work.
3. Patching shall be as specified and indicated, and shall include: Fill holes and depressions left as a result of removals in existing masonry or concrete walls with an approved patching material, applied in accordance with the manufacturer's printed instructions.

D. Electrical:

1. Cut off concealed or embedded conduit, boxes, or other materials a minimum of 3/4 inch below final finished surface.
2. When removing designated equipment, conduit and wiring may require rework to maintain service to other equipment.
3. Rework existing circuits, or provide temporary circuits as necessary during renovation to maintain service to existing lighting and equipment not scheduled to be renovated. Existing equipment and circuiting shown are based upon limited field surveys. Verify existing conditions, make all necessary adjustments, and record the Work on the Record Drawings. This shall include, but is not limited to, swapping and other adjustments to branch circuits and relocation of branch circuit breakers within panelboards as required to accomplish the finished work.
4. Reuse of existing luminaires, devices, conduits, boxes, or equipment will be permitted only where specifically indicated.
5. Raceways and cabling not scheduled for reuse.
6. Inaccessibly Concealed: Cut off and abandon in place.
7. Exposed or Concealed Above Accessible Ceilings: Remove.
8. Raceways and Cabling Scheduled for Future Use: Cap/seal and tag.
9. Relocating Equipment: Extend existing wiring or run new wiring from the source.
10. Where the existing raceway is concealed, the outlet box shall be cleaned, and a blank cover plate installed.
11. Where the concealed raceway is uncovered remove raceway (or extended to new location if appropriate).
12. Provide new typewritten panelboard circuit directory cards.

3.02 PROTECTION

A. Dust and Debris Control:

1. Prevent the spread of dust and debris to occupied portions of the building and avoid the creation of a nuisance in the surrounding area. Do not use water if it results in hazardous or objectionable conditions such as, but not limited to, ice, flooding, or pollution.
2. Sweep pavements as often as necessary to control the spread of debris that may result in foreign object damage potential to vehicular traffic.

B. Existing Work:

1. Survey the site and examine the Drawings and Specifications to determine the extent of the Work before beginning any demolition or renovation.

2. Take necessary precautions to avoid damage to existing items scheduled to remain in place, to be reused, or to remain the property of Owner; any Contractor-damaged items shall be repaired or replaced as directed by Engineer.
3. Ensure that structural elements are not overloaded as a result of or during performance of the Work. Responsibility for additional structural elements or increasing the strength of existing structural elements as may be required as a result of any Work performed under this Contract shall be that of the Contractor. Repairs, reinforcement, or structural replacement must have Engineer approval.
4. Do not overload pavements to remain.

C. Protection of Personnel:

1. Provide temporary barricades and other forms of protection to protect Owner's personnel and the general public from injury due to demolition Work.
2. Provide protective measures as required to provide free and safe passage of Owner's personnel and the general public to occupied portions of the structure.

3.03 BURNING

- A. The use of burning at the Site for the disposal of refuse and debris will not be permitted.

3.04 RELOCATIONS

- A. Perform the removal and reinstallation of relocated items as indicated with workmen skilled in the trades involved. Clean all items to be relocated prior to reinstallation, to the satisfaction of Engineer. Repair items to be relocated which are damaged or replace damaged items with new undamaged items as approved by Engineer.

3.05 TITLE TO MATERIALS

- A. All salvaged equipment will remain the property of Owner.
- B. With the exception of the following listed salvaged equipment, all items designated to be removed shall become the property of Contractor:
1. Sodium chlorite feed pump and associated controller.
 2. Both chlorine dioxide feed pumps and associated controllers.

3.06 CLEANUP

- A. Debris and rubbish shall be removed and transported in a manner that prevents spillage on streets or adjacent areas. Local regulations regarding hauling and disposal shall apply.

END OF SECTION

SECTION 03 01 32
REPAIR OF VERTICAL AND OVERHEAD CONCRETE SURFACES

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American Concrete Institute (ACI):
 - a. 301, Specifications for Structural Concrete.
 - b. 506.2, Specification for Shotcrete.
2. ASTM International (ASTM):
 - a. A1064/A1064 M Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete.
 - b. A615/A615M, Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
 - c. A706/A706M, Standard Specification for Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement.
 - d. C42/C42M, Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete.
 - e. C78/C78M, Standard Test Method for Flexural Strength of Concrete (Using Simple Beam with Third-Point Loading).
 - f. C109/C109M, Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or [50-mm] Cube Specimens).
 - g. C157/C157M, Standard Test Method for Length Change of Hardened Hydraulic-Cement Mortar and Concrete.
 - h. C348, Standard Test Method for Flexural Strength of Hydraulic-Cement Mortars.
 - i. C496/C496M, Standard Test Method for Splitting Tensile Strength of Cylindrical Concrete Specimens.
 - j. C531, Standard Test Method for Linear Shrinkage and Coefficient of Thermal Expansion of Chemical-Resistant Mortars, Grouts, Monolithic Surfacing, and Polymer Concretes.
 - k. C596, Standard Test Method for Drying Shrinkage of Mortar Containing Hydraulic Cement.
 - l. C666/C666M, Standard Test Method for Resistance of Concrete to Rapid Freezing and Thawing.
 - m. C882/C882M, Standard Test Method for Bond Strength of Epoxy-Resin Systems Used with Concrete by Slant Shear.
 - n. C1202, Standard Test Method for Electrical Indication of Concrete's Ability to Resist Chloride Ion Penetration.

- o. C1583/C1583M, Standard Test Method for Tensile Strength of Concrete Surfaces and the Bond Strength or Tensile Strength of Concrete Repair and Overlay Materials by Direct Tension (Pull-off Method).
- p. D4258, Standard Practice for Surface Cleaning Concrete for Coating.
- q. D4259, Standard Practice for Abrading Concrete.
- r. E699, Standard Practice for Evaluation of Agencies Involved in Testing, Quality Assurance, and Evaluating of Building Components.

1.02 DEFINITIONS

- A. Abrasive Blasting: Surface preparation method that uses compressed air intermixed with an abrasive medium to clean surface of substrate concrete, exposed steel, and steel reinforcement. Compressed air and abrasive medium is projected at high speed through a nozzle directly at the surface. Method is used to remove corrosion by-products, laitance, or other materials that may inhibit bond of repair concrete.
- B. Defective Area: As defined in Section 03 30 00, Cast-in-Place Concrete.
- C. High-Pressure Water Blasting: Sometimes referred to as hydro-demolition. Uses water that may contain an abrasive medium, projected under high pressure and high velocity. Used for demolition, cutting, partial or full depth removal, cleaning, scarifying, or roughening of concrete surfaces, or removing existing coatings, for preparation of substrate concrete surfaces.
- D. New Concrete: As defined in Section 03 30 00, Cast-in-Place Concrete.

1.03 SUBMITTALS

- A. Action Submittals:
 - 1. Product data sheets for each material supplied.
 - 2. Drawings supplemented by photographs indicating location, size, estimated quantity, and proposed repair mortar for each repair location in existing concrete.
 - 3. Drawings indicating results of sounding for hollow areas including location, size, and estimated quantity of hollow-sounding areas for each repair location.
- B. Informational Submittals:
 - 1. Repair Mortar System: Manufacturer's preparation and installation instructions.

2. Written description of equipment proposed for concrete removal and surface preparation.
3. Certificates:
 - a. Manufacturer's Certificate of Compliance, in accordance with Section 01 61 00, Common Product Requirements, that proposed repair mortar systems are prepackaged, shrinkage compensated, specially designed for use on vertical and overhead surfaces that are exposed to potable water.
 - b. Mortar Manufacturer's Certificate of Proper Installation.
4. Statements of Qualification:
 - a. Repair mortar system applicator.
 - b. Repair mortar system manufacturer's representative.
 - c. Independent Testing Laboratory.
5. Repair mortar system manufacturer's proposed modified test procedures for ASTM C109/C109M, ASTM C882/C882M, and ASTM C157/C157M test methods.
6. Field and laboratory test reports.

1.04 QUALITY ASSURANCE

- A. Qualifications: Repair Mortar System Manufacturer's Representative: Knowledgeable and experienced on technical data and application requirements for specified products.
- B. Independent Testing Laboratory: Meet criteria stated in ASTM E699.
- C. Pre-repair Conference:
 1. Required Meeting Attendees:
 - a. Contractor.
 - b. Repair Subcontractor.
 - c. Technical representative for repair material manufacturer.
 - d. Engineer.
 2. Schedule and conduct prior to conducting mockups and incorporation of respective products into Project. Notify Engineer of location and time.
 3. Agenda shall include, but not limited to:
 - a. Review of field conditions. Conduct field observations of Work to be performed.
 - b. Based on above observations, repair material manufacturer's technical representative shall confirm material selection and make Project-specific repair method recommendations.
 - c. Technical representative for repair material manufacturer shall review proposed surface preparation, material application, consolidation, finishing, curing, and protection of repair material from weather conditions.
 - d. Other specified requirements requiring coordination.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Package repair mortar system products in moisture-resistant bags, pails, or moisture-resistant bulk bags.
- B. Deliver, store, and handle repair materials in accordance with manufacturer's printed instructions.

PART 2 PRODUCTS

2.01 REPAIR SYSTEM C – POLYMER-MODIFIED REPAIR MORTAR

- A. Polymer-modified, one- or two-component, cementitious based, chloride resistant, flowable, gray in color, working time of 20 minutes minimum, surface renovation mortar.
- B. Cured Mortar Properties:
 - 1. Compressive Strength, ASTM C109/C109M at 28 Days: 7,000 psi minimum.
 - 2. Flexural Strength, ASTM C348 at 28 Days: 1,200 psi minimum.
 - 3. Slant Shear Bond Strength, ASTM C882/C882M Test Method Modified with No Bonding Agent at 28 Days: 2,000 psi minimum.
 - 4. Splitting Tensile Strength, ASTM C496/C496M at 28 Days: 500 psi minimum.
 - 5. Drying Shrinkage, ASTM C596 at 28 Days: 0.12 percent maximum. Not required for small repair areas approximately 1 square foot in area or less.
 - 6. Freeze Thaw Resistance, ASTM C666/C666M, at 300 Cycles: 90 percent RDM.
 - 7. Chloride Ion Permeability Based on Charge Passed, ASTM C1202: 800 coulombs maximum for liquid holding and belowgrade repairs.
- C. Manufacturers and Products:
 - 1. Sika Corp., Lyndhurst, NJ; SikaTop 123 PLUS.
 - 2. Euclid Chemical Co., Cleveland, OH; DuralTop Gel.

2.02 WATER

- A. Clean and free from oil, acid, alkali, organic matter, or other deleterious substances, meeting federal drinking water standards, as specified in Section 03 30 00, Cast-in-Place Concrete.

2.03 REINFORCEMENT

- A. As specified in Section 03 21 00, Steel Reinforcement.

2.04 EVAPORATION RETARDANT

- A. As specified in Section 03 39 00, Concrete Curing.

2.05 CURING COMPOUND

- A. As specified in Section 03 39 00, Concrete Curing.

PART 3 EXECUTION

3.01 GENERAL

- A. New Concrete Work: Repair deficiencies in new concrete structures constructed under this Contract with applicable repair system. Refer to Section 03 30 00, Cast-in-Place Concrete.

3.02 PREPARATION

- A. Identify unsound and deteriorated concrete by sounding techniques, or as directed by Engineer, and review proposed extent of repair with Engineer.
- B. Remove unsound, honeycombed, deteriorated, or otherwise defective areas of concrete from work areas.
 - 1. Use psi minimum high-pressure water blasting machine as required for Site conditions.
 - 2. Remove concrete to abrade substrate concrete surfaces to a minimum amplitude roughness of 3/16 inch measured between high and low points with a 3-foot-long straightedge, in accordance with ASTM D4259.
 - 3. Where final surface is required to be flush with existing adjacent surface remove existing concrete depth as required for application of minimum thickness of repair mortar.
- C. Do not use power-driven jackhammers, chipping hammers, or scabblers unless water blasting is not permitted or practical because of Site conditions, or may cause other damage to equipment or facilities. In such cases where chipping hammers are required, limit size of chipping hammer to 16 pounds or lighter, or use small electric chipping hammer, to reduce formation of micro-fractures in substrate concrete surface.
- D. Following removal of unsound or deteriorated concrete, check substrate concrete surface by sounding techniques to identify unsound concrete remaining or resulting from use of chipping hammer.
- E. Remove unsound concrete to satisfaction of Engineer.

- F. Square edges of patch areas by sawing or chipping to avoid tapered shoulders or feathered edges. Avoid cutting embedded steel reinforcement. Roughen polished saw-cut edge by high-pressure water blasting.
- G. Remove concrete adjacent to steel reinforcement to a minimum of 1-inch clearance around steel reinforcement for application and bonding of new repair mortar to circumference of exposed steel reinforcement if one or more of the following surface conditions exist:
 - 1. 50 percent or more of circumference around steel reinforcement is exposed during concrete removal.
 - 2. 25 percent or more of circumference around steel reinforcement is exposed during concrete removal and corrosion is present to extent that more than 25 percent loss of section has occurred.
 - 3. Otherwise evident that bond between existing concrete and steel reinforcement has been destroyed or has deteriorated as determined by Engineer.
- H. Clean exposed steel reinforcement of loose rust and concrete splatter per recommendations of repair material manufacturer and in accordance with ASTM D4258.
- I. Keep areas from which concrete has been removed free of dirt, dust, and water blasting waste slurry. Remove laitance and other bond inhibiting contaminants from prepared areas.
- J. Dampen repair areas at least 6 inches beyond area to receive repair mortar for at least 24 hours to provide saturated surface dry (SSD) condition without standing water at time of application of mortar as required by and in accordance with repair mortar manufacturer's printed instructions.
- K. Collect and dispose of spent water and concrete debris from removal operations offsite in manner and location acceptable to Owner.

3.03 REINFORCEMENT INSTALLATION

- A. Provide steel reinforcement when existing reinforcement is not exposed, and when mortar application is more than 3 inches deep, unless otherwise shown on Drawings.
- B. Coat exposed new and existing steel reinforcement with cementitious reinforcement coating at same time as substrate concrete is coated, as specified below, per repair mortar and cementitious reinforcement coating manufacturers' printed instructions.

3.04 PROTECTION

- A. If cementitious coating or bonding agent is used, protect adjacent surfaces from over application. Promptly remove bonding agent applied beyond repair area.

3.05 REPAIR SYSTEM C – POLYMER-MODIFIED REPAIR MORTAR PLACEMENT

- A. Mix mortar in accordance with manufacturer's printed instructions.
- B. Bond Coat: Apply to prepared substrate concrete surface before application of mortar in accordance with repair mortar manufacturer's printed instructions. Do not apply more bond coat than can be covered with mortar before bond coat dries. Do not retemper bond coat.
- C. Place mortar by hand or low-pressure spray and trowel to specified surface finish, in accordance with requirements of repair material's printed instructions.
- D. Finish repair mortar to smooth even surface to match adjacent concrete surface.
- E. Cure as specified in Article Curing, and in accordance with manufacturer's printed instructions.

3.06 CURING

- A. Prior to curing, apply water fog to repair mortar system in accordance with repair mortar system manufacturer's printed instructions.
- B. Cure in accordance with repair mortar manufacturer's printed instructions.
- C. Where permitted by repair mortar manufacturer's printed instructions, commence water curing after repair mortar system application and when curing will not cause erosion of mortar.
- D. Continuously water cure repair mortar system for a period of 7 days.
- E. Do not cure using curing compound or membrane, unless method is part of repair mortar system manufacturer's printed instructions and approval is obtained from Engineer.
- F. Cure intermediate layers of repair mortar in accordance with repair mortar manufacturer's printed instructions.

- G. Where curing compound is permitted by repair mortar system manufacturer, apply curing compound in accordance with Section 03 39 00, Concrete Curing.

3.07 FIELD QUALITY CONTROL

A. Sounding for Hollow Areas:

1. Light hammer tap repaired areas listening for hollow sound to determine areas that have not properly bonded to substrate concrete.
2. Mark hollow areas for removal and replacement.

B. Compression Strength Test:

1. Test in accordance with ASTM C109/C109M, except modified by making samples using repair mortar.
2. Obtain production samples of mixed wet mortar materials from nozzle, or mixer, during construction for compliance with Specifications for testing at 7 days, and 28 days. Alternatively, take core samples in accordance with ASTM C42/C42M from applied mortar material for testing at 7 days and 28 days.
3. Provide a minimum of three samples for each 200 square feet of mortar repair, and a minimum of three samples in total, whichever is greater, for testing.
4. Record location where repair mortar is being applied at time production samples are obtained.

C. Direct Tension Bond Test:

1. In Situ Bond Testing: Perform tension bond test in accordance with ASTM C1583/C1583M.
2. Record locations on in situ bond tests on each type of applied repair mortar.

D. Testing laboratory retained by Owner will provide the following:

1. Compression Strength Test:
 - a. Testing will follow a “modified” ASTM C109/C109M.
 - b. A minimum of three production samples of mixed material will be obtained from each 200 square feet of mortar repair, and a minimum of three samples in total, whichever is greater, for testing at 7 days, and 28 days.
 - c. Record location where repair mortar is being applied at time production samples are obtained.
2. Direct Tension Bond Test:
 - a. Two core samples will be obtained and tested for each 2,000 square feet of repair work.

- b. Cores will be 2-1/2-inch or 3-inch diameter to a total depth equal to at least 2.5 times repair mortar thickness.
- c. Bond Strength of Repair Mortar to Substrate Concrete: 300 psi minimum in direct tension without failure or movement.
- d. Record locations of Bond Tests on each type of applied repair mortar tested.

- E. Retest mortar repairs that do not meet test requirements.
- F. Repair and fill holes using same repair mortar where core samples have been removed.

3.08 MORTAR REPAIR FAILED TEST

- A. Remove and replace unacceptable Work.
- B. Hollow Sounding Areas: Saw cut hollow sounding areas to a new square edge. Remove unsound mortar repair. Prepare substrate surface and reapply repair mortar as specified herein above.
- C. Failed Compression Strength Test: Remove affected areas of repair mortar represented by failed compression strength test results. Prepare substrate surface and reapply repair mortar as specified herein above.
- D. Failed Bond Tests: Remove affected areas of repair mortar represented by failed bond test results. Prepare substrate surface and reapply repair mortar as specified herein above.
- E. Retest areas where repair mortar was removed and replaced, in accordance with test requirements specified herein above.

3.09 MANUFACTURER'S SERVICES

- A. Provide repair mortar system manufacturer's representative at Site to review acceptability of surface preparation, mixing and installation assistance, training of repair mortar system applicators, inspection, and Certification of Proper Installation.

3.10 CLEANING

- A. Remove waste materials, unsound material from concrete surfaces, material chipped from structure, and water used in preparation of or repair areas, finishing, and curing, and dispose offsite at an approved disposal site.

END OF SECTION

SECTION 03 01 33 REPAIR OF HORIZONTAL CONCRETE SURFACES

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American Association of State Highway and Transportation Officials (AASHTO): T277, Standard Method of Test for Electrical Indication of Concrete's Ability to Resist Chloride Ion Penetration.
2. ASTM International (ASTM):
 - a. A1064/A1064 M, Standard Specification for Steel Wire, Plain, for Concrete Reinforcement.
 - b. A1064/A1064 M, Standard Specification for Steel Welded Wire Reinforcement, Plain, for Concrete.
 - c. A615/A615M, Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
 - d. A706/A706M, Standard Specification for Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement.
 - e. C42/C42M, Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete.
 - f. C78/C78M, Standard Test Method for Flexural Strength of Concrete (Using Simple Beam with Third-Point Loading).
 - g. C109/C109M, Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or [50-mm] Cube Specimens).
 - h. C157/C157M, Standard Test Method for Length Change of Hardened Hydraulic-Cement Mortar and Concrete.
 - i. C348, Standard Test Method for Flexural Strength of Hydraulic-Cement Mortars.
 - j. C469, Standard Test Method for Static Modulus of Elasticity and Poisson's Ratio of Concrete in Compression.
 - k. C496/C496M, Standard Test Method for Splitting Tensile Strength of Cylindrical Concrete Specimens.
 - l. C666/C666M, Standard Test Method for Resistance of Concrete to Rapid Freezing and Thawing.
 - m. C779/C779M, Standard Test Method for Abrasion Resistance of Horizontal Concrete Surfaces.
 - n. C882/C882M, Standard Test Method for Bond Strength of Epoxy-Resin Systems Used with Concrete by Slant Shear.
 - o. C928/C928M, Standard Specification for Packaged, Dry, Rapid-Hardening Cementitious Materials for Concrete Repairs.

- p. C1012/C1012M, Standard Test Method for Length Change of Hydraulic-Cement Mortars Exposed to a Sulfate Solution.
- q. C1202, Standard Test Method for Electrical Indication of Concrete's Ability to Resist Chloride Ion Penetration.
- r. C1583/C1583M, Standard Test Method for Tensile Strength of Concrete Surfaces and the Bond Strength or Tensile Strength of Concrete Repair and Overlay Materials by Direct Tension (Pull-off Method).
- s. D638, Standard Test Method for Tensile Properties of Plastics.
- t. D695, Standard Test Method for Compressive Properties of Rigid Plastics.
- u. D4258, Standard Practice for Surface Cleaning Concrete for Coating.
- v. D4259, Standard Practice for Abrading Concrete.
- w. E699, Standard Practice for Evaluation of Agencies Involved in Testing, Quality Assurance, and Evaluating of Building Components.

1.02 DEFINITIONS

- A. Defective Area: As defined in Section 03 30 00, Cast-in-Place Concrete.
- B. High-Pressure Water Blasting (sometimes referred to as hydro-demolition): Uses water that may contain an abrasive medium, projected under high pressure and high velocity. Used for demolition, cutting, partial or full depth removal, cleaning, scarifying, or roughening of concrete surfaces, or removing existing coatings, for preparation of substrate concrete surfaces.
- C. New Concrete: As defined in Section 03 30 00, Cast-in-Place Concrete.

1.03 SUBMITTALS

- A. Action Submittals:
 - 1. Product data sheets for each material supplied.
 - 2. Drawings supplemented by photographs indicating location, size, estimated quantity, and proposed repair mortar system for each repair location in existing concrete.
 - 3. Drawings indicating results of sounding for hollow areas including location, size, estimated quantity, of hollow-sounding areas for each repair location.
- B. Informational Submittals:
 - 1. Repair Mortar System: Manufacturer's preparation and installation instructions.

2. Written description of equipment proposed for concrete removal and surface preparation.
3. Certificates:
 - a. Manufacturer's Certificate of Compliance in accordance with Section 01 61 00, Common Product Requirements, that proposed repair mortar systems meet requirements of ASTM C928/C928M.
 - b. Manufacturer's Certificate of Compliance, in accordance with Section 01 61 00, Common Product Requirements, that repair mortar systems are prepackaged, shrinkage compensated, specially designed for use on horizontal surfaces that are exposed to weather, potable water, and receive traffic.
 - c. Mortar Manufacturer's Certificate of Proper Installation.
 - d. Confirmation epoxy resin bonding agents conform to ASTM C882/C882M.
4. Statements of Qualification:
 - a. Repair mortar system applicator.
 - b. Independent Testing Laboratory.
5. Field and laboratory test results.

1.04 QUALITY ASSURANCE

A. Qualifications:

1. Repair Mortar System Applicator: Trained and experienced applicator endorsed by repair mortar system manufacturer.
2. Repair Mortar System Manufacturer's Representative: Knowledgeable and experienced on technical data and application requirements for specified products.

B. Independent Testing Laboratory: Meet criteria stated in ASTM E699.

C. Pre-repair Conference:

1. Required Meeting Attendees:
 - a. Contractor.
 - b. Repair Subcontractor.
 - c. Technical representative for repair material manufacturer.
 - d. Engineer.
2. Schedule and conduct prior to incorporation of respective products into Project. Notify Engineer of location and time.
3. Agenda shall include, but not limited to:
 - a. Review of field conditions. Conduct field observations of the Work to be performed.
 - b. Based on above observations, repair material manufacturer's technical representative shall confirm material selection and make Project specific repair method recommendations.

- c. Technical representative for repair material manufacturer shall review proposed surface preparation, material application, consolidation, finishing, curing, and protection of repair material from weather conditions.
- d. Other specified requirements requiring coordination.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Package repair mortar system products in moisture-resistant bags, pails, or moisture-resistant bulk bags.
- B. Deliver, store, and handle repair materials in accordance with manufacturer's printed instructions.

PART 2 PRODUCTS

2.01 REPAIR MORTAR SYSTEM NO. 5—POLYMER MODIFIED REPAIR MORTAR

- A. One or two-component, fast-setting, polymer modified cementitious based repair mortar system.
- B. Compressive Strength, ASTM C109/C109M:
 - 1. 1 Day: 2,500 psi minimum.
 - 2. 7 Days: 5,000 psi minimum.
 - 3. 28 Days: 7,000 psi minimum.
- C. Flexural Strength, ASTM C348 at 28 Days: 1,500 psi minimum.
- D. Slant Shear Bond Strength, ASTM C882/C882M Modified at 28 Days: 2,000 psi minimum.
- E. Splitting Tensile Strength, ASTM C496/C496M at 28 Days: 600 psi minimum.
- F. Abrasion Resistance Depth of Wear, ASTM C779/C779M, Procedure A, at 60 Minutes: 0.033 inch maximum.
- G. Drying Shrinkage, ASTM C157/C157M Modified, at 28 Days: 0.09 percent maximum.
- H. Rapid Chloride Ion Permeability Based on Charge Passed, ASTM C1202: 28 Days: Under 850 coulombs maximum.

I. Manufacturers and Products:

1. BASF Construction Chemicals, LLC - Building Systems, Shakopee, MN; MasterEmaco T 545.
2. Euclid Chemical Co., Cleveland, OH; Duraltop Flowable Mortar.
3. Sika Corp., Lyndhurst, NJ; SikaTop 111 PLUS.

2.02 WATER

- A. Clean and free from oil, acid, alkali, organic matter, or other deleterious substances, meeting federal drinking water standards, as specified in Section 03 30 00, Cast-in-Place Concrete.

2.03 REINFORCEMENT

- A. Deformed Steel reinforcement:
- B. Per Section 03 21 00, Steel Reinforcement.

2.04 EPOXY BONDING AGENT

- A. Two-component, moisture insensitive, 100 percent solids epoxy resin.
- B. Tensile Strength, ASTM D638, at 14 Days: 4,400 psi minimum.
- C. Elongation at Break, ASTM D638: 1.49 percent minimum.
- D. Compressive Strength, ASTM D695, at 28 Days for Application Temperature of 73 Degrees F to 77 Degrees F: 8,000 psi minimum.
- E. Bond Strength, ASTM C882/C882M, at 14 Days: 1,800 psi minimum.
- F. Pot Life, at 73 Degrees F to 77 Degrees F: 75 minutes minimum.
- G. Manufacturers and Products:
 1. BASF Corporation Construction Systems, Shakopee, MN; MasterEmaco ADH 326 when ambient temperature is 73 degrees F or higher.

2.05 EVAPORATION RETARDANT

- A. As specified in Section 03 39 00, Concrete Curing.

2.06 CURING COMPOUND

- A. As specified in Section 03 39 00, Concrete Curing.

PART 3 EXECUTION

3.01 GENERAL

- A. New Concrete Work: Repair deficiencies in new concrete structures constructed under this Contract with applicable repair system.

3.02 PREPARATION

- A. Identify unsound and deteriorated concrete by sounding techniques, or as directed by Engineer. Review proposed extent of repair with Engineer.
- B. Remove unsound, deteriorated, or otherwise defective areas of concrete from Work areas.
 - 1. Use 8,000 psi minimum high-pressure water blasting machine, as appropriate to suit Site conditions.
 - 2. Remove concrete to abrade substrate concrete surface to a minimum amplitude roughness of 3/16 inch measured between high and low points with a 3-foot-long straightedge, in accordance with ASTM D4259.
 - 3. Where final surface is required to be flush with existing adjacent surface, remove existing concrete depth as required for application of minimum thickness of repair mortar.
- C. Do not use power-driven jackhammers, chipping hammers, scabblers, or scarifiers unless water blasting is not permitted or practical because of Site conditions, or may cause other damage to equipment or facilities. In such cases where chipping hammers are required, limit size of chipping hammer to 16 pounds or lighter, or use small electric chipping hammer, to reduce formation of micro-fractures in substrate concrete surface.
- D. Following removal of unsound or deteriorated concrete, check substrate concrete surface by sounding techniques to identify unsound concrete remaining or resulting from use of chipping hammer.
- E. Remove unsound concrete to satisfaction of Engineer.
- F. Square edges of patch areas by sawing or chipping to avoid tapered shoulders or feathered edges. Avoid cutting embedded steel reinforcement. Roughen polished saw-cut edge by high-pressure water blasting.

- G. Remove concrete adjacent to steel reinforcement to a minimum of 1-inch clearance around steel reinforcement for application and bonding of new repair mortar to entire circumference of exposed steel reinforcement if one or more of the following surface conditions exist:
 - 1. 50 percent or more of circumference around steel reinforcement is exposed during concrete removal.
 - 2. 25 percent or more of circumference around steel reinforcement is exposed during concrete removal and corrosion is present to extent that more than 25 percent loss of section has occurred.
 - 3. Otherwise evident that bond between existing concrete and steel reinforcement has been destroyed or has deteriorated as determined by Engineer.
- H. Clean exposed steel reinforcement of loose rust and concrete splatter per recommendations of repair material manufacturer and in accordance with ASTM D4258.
- I. Keep areas from which concrete has been removed free of dirt, dust, and water blasting waste slurry. Remove laitance and other bond inhibiting contaminants from prepared areas.
- J. Substrate Concrete Surface in Areas to Receive Repair Mortar: Dampen repair areas at least 6 inches beyond area to receive repair mortar for at least 24 hours to provide saturated surface dry (SSD) condition without standing water at time of application of mortar, as required by and in accordance with repair mortar manufacturer's printed instructions.
- K. Collect and dispose of spent water and concrete debris from removal operations offsite in manner and location acceptable to Owner.

3.03 REINFORCEMENT INSTALLATION

- A. Provide steel reinforcement when existing steel reinforcement is not exposed and when mortar application is more than 4 inches deep, unless otherwise shown on Drawings.
- B. Replace deteriorated steel reinforcement with new steel reinforcement equivalent in cross-sectional area to original steel reinforcement.
- C. Fasten steel reinforcement to chairs with tie wire to prevent from moving during placement of repair mortar.

3.04 PROTECTION

- A. If cementitious coating or bonding agent is used, protect adjacent surfaces from over application. Promptly remove bonding agent applied beyond repair area.
- B. Protect adjacent surfaces, and equipment from spillage of repair mortar and dust, as applicable for repair mortar system used.

3.05 PLACEMENT

- A. Repair Mortar System No. 5:
 - 1. Remove standing and free water from prepared area.
 - 2. Apply bond scrub coat of mortar to prepared surface in accordance with manufacturer's instructions. Do not apply more scrub coat of mortar than can be covered with repair mortar before scrub coat begins drying.
 - 3. Immediately place mixed repair mortar into prepared area from one side to the other side.
 - 4. Work material firmly into bottom and sides of patch to ensure a good continuous bond.
 - 5. Level repair mortar and screed to elevation of existing concrete.
 - 6. Finish to same texture as existing concrete around patch.
 - 7. Screed or use self-leveling mixture to obtain a uniform and plane surface.
- B. Joint Repair:
 - 1. Remove joint spacer when repair mortar is hard enough that a pointed trowel will penetrate surface less than 1/2 inch.
 - 2. When repair mortar is cured and ready for use, fill joint in accordance with repair mortar system manufacturer's instructions.

3.06 FINISHING

- A. Spray full strength evaporation retardant on fresh concrete to prevent rapid drying during hot and windy weather.

3.07 CURING

- A. Apply curing compound in accordance with Section 03 39 00, Concrete Curing.

3.08 FIELD QUALITY CONTROL

A. Sounding for Hollow Areas:

1. Chain drag or light hammer tap repaired areas listening for hollow sound to determine areas that have not properly bonded to substrate concrete.
2. Mark hollow areas for removal and replacement.

B. Compression Strength Test:

1. Test in accordance with ASTM C109/C109M, except modified by making samples using repair mortar.
2. Obtain production samples of mixed materials from mixer during construction for compliance with Specifications.
3. Provide minimum of three samples for each 200 square feet of mortar repair, and a minimum of three samples in total, whichever is greater for testing.
4. Record location where repair mortar is being applied at time production samples are obtained.

C. Direct Tension Bond Test:

1. In Situ Bond Testing: Perform tension bond test in accordance with ASTM C1583/C1583M.
2. Record locations on in situ bond tests on each type of applied repair mortar.

D. Testing laboratory retained by Owner will provide the following:

1. Compression Strength Test:
 - a. Testing will follow a “modified” ASTM C109/C109M.
 - b. A minimum of three production samples of mixed material will be obtained from each 200 square feet of mortar repair, and a minimum of three samples in total, whichever is greater, for testing at 7 days, and 28 days.
 - c. Record location where repair mortar is being applied at time production samples are obtained.
2. Direct Tension Bond Test:
 - a. Two core samples will be obtained and tested for each 2,000 square feet of repair work.
 - b. Cores will be 2-1/2-inch or 3-inch diameter to a total depth equal to at least 2.5 times repair mortar thickness.
 - c. Bond Strength of Repair Mortar to Substrate Concrete: 300 psi minimum in direct tension without failure or movement.
 - d. Record locations of bond tests on each type of applied repair mortar tested.

- E. Retest mortar repairs that do not meet test requirements.
- F. Repair and fill holes using same repair mortar where core samples have been removed.

3.09 MORTAR REPAIR FAILED TEST

- A. Remove and replace unacceptable Work.
- B. Hollow Sounding Areas: Saw cut hollow sounding areas to a new square edge, remove unsound mortar repair. Prepare substrate surface and reapply repair mortar as specified herein above.
- C. Failed Compression Strength Test: Remove affected areas of repair mortar represented by failed compression strength test results. Prepare substrate surface and reapply repair mortar as specified herein above.
- D. Failed Bond Tests: Remove affected areas of repair mortar represented by failed bond test results. Prepare substrate surface and reapply repair mortar as specified herein above.
- E. Retest areas where repair mortar was removed and replaced, in accordance with test requirements specified herein above.

3.10 MANUFACTURERS' SERVICES

- A. Provide mortar manufacturer's representative at Site to advice on product selection, review acceptability of surface preparation, mixing and installation assistance, inspection, and Certification of Proper Installation.

3.11 CLEANING

- A. Remove excess repair mortar materials as the Work proceeds. Remove waste materials, unsound material from concrete surfaces, material chipped from structure, and water used in preparation of repair areas, finishing, and curing, and dispose offsite at approved disposal site.

END OF SECTION

SECTION 03 10 00
CONCRETE FORMING AND ACCESSORIES

PART 1 GENERAL

1.01 REFERENCES

- A. The following is a list of standards which may be referenced in this section:
 - 1. American Concrete Institute (ACI):
 - a. 117, Specification for Tolerances for Concrete Construction and Materials.
 - a. 301, Specifications for Structural Concrete.
 - b. 350, Code Requirements for Environmental Engineering Concrete Structures.

1.02 DEFINITIONS

- A. Defective Areas: See definition in Section 03 30 00, Cast-in-Place Concrete.
- B. Exposed Concrete: See definition in Section 03 30 00, Cast-in-Place Concrete.

1.03 DESIGN REQUIREMENTS

- A. Design formwork in accordance with ACI 301 and ACI 318 to provide concrete finishes specified in Section 03 30 00, Cast-in-Place Concrete.
- B. Unless otherwise specified, limit deflection of facing materials for concrete surfaces to comply with ACI 301. Limit deflection of facing materials to comply with tolerance limits established by Contract Documents and with tolerances required by equipment manufacturers. Coordinate tolerance requirements with equipment manufacturers.

1.04 SUBMITTALS

- A. Action Submittals:
 - 1. Shop Drawings:
 - a. Formwork drawings signed and sealed by a licensed professional engineer in the state of the Project.
 - b. Layout of panel joints and tie hole pattern.
 - 2. Product Data:
 - a. Form release agent.
 - b. Form ties.
 - c. Products to be used for sealing tie holes.
- B. Informational Submittals: Statement of qualifications for formwork designer.

1.05 QUALITY ASSURANCE

A. Qualifications:

1. Formwork Designer: Formwork, falsework, and shoring design shall be designed by an engineer licensed in the state of Project.

PART 2 PRODUCTS

2.01 FORM MATERIALS

A. Wall Forms:

1. Materials: Plywood, hard plastic finished plywood, overlaid waterproof particle board, or steel in “new and undamaged” condition, of sufficient strength and surface smoothness to produce specified finish.
2. Where steel forms are used, treat steel surfaces to prevent rusting using

B. Sandblasted Surface Forms: Medium-density overlay plywood for flat concrete surfaces to be sandblasted.

C. Painted Surface Forms: High-density overlay plywood for flat concrete surfaces to be painted.

D. All Other Forms: Materials as specified for wall forms.

2.02 ACCESSORIES

A. Form Release Agent:

1. Material:
 - a. Shall not bond with, stain, or adversely affect concrete surfaces.
 - b. Shall not impair subsequent treatments of concrete surfaces when applied to forms.
 - c. Ready-to-use water based material formulated to reduce or eliminate surface imperfections.
 - d. Contain no mineral oil or organic solvents.
2. Manufacturers and Products: Not for surfaces exposed to potable water.
 - a. BASF, Shakopee, MN; MBT MasterFinish RL 211.
 - b. Cresset Chemical Company; Crete-Lease 20-VOC-Xtra.
3. Manufacturers and Products: For use with potable water structures. Environmentally safe, meeting local, state, and federal regulations and usable in potable water facilities.
 - a. Atlas Tech Products; Atlas Bio-Guard.
 - b. Dayton Superior; Clean Strip J1EF.
 - c. Hill and Griffith Company; Grifcote LV-50-Plus.

- B. Rustication Grooves and Beveled Edge Corner Strips: Nonabsorbent material, compatible with form surface, fully sealed on all sides prohibiting loss of paste or water between the two surfaces.
- C. Form Snap-Ties:
 - 1. Material: Steel.
 - 2. Spreader Inserts:
 - a. Conical or spherical type.
 - b. Design to maintain positive contact with forming material.
 - c. Furnish units that will leave no metal closer than 1.5 inches to concrete surface when forms, inserts, and tie ends are removed.
 - 3. Wire ties not permitted.
 - 4. Flat bar ties for panel forms; furnish plastic or rubber inserts with minimum 1.5-inch depth and sufficient dimensions to permit patching of tie hole.
- D. Form Snap-Ties with Water Stop:
 - 1. For water-holding structures, basements, pipe galleries, and accessible spaces below finish grade, furnish one of the following:
 - a. Integral steel water stop 0.103-inch thick and 0.625-inch diameter tightly and continuously welded to tie.
 - b. Neoprene water stop 3/16-inch thick and 15/16-inch diameter whose center hole is one-half diameter of tie, or molded plastic water stop of comparable size.
 - c. Orient water stop perpendicular to tie and symmetrical about center of tie.
 - d. Design ties to prevent rotation or disturbance of center portion of tie during removal of ends and to prevent water leaking along tie.

PART 3 EXECUTION

3.01 FORM SURFACE PREPARATION

- A. Prior to coating surface, thoroughly clean form surfaces that will be in contact with concrete or that have been in contact with previously cast concrete, dirt, and other surface contaminants.
- B. Exposed Wood Forms in Contact with Concrete: Apply form release agent as recommended by manufacturer.
- C. Steel Forms: Apply form release agent as soon as they are cleaned to prevent discoloration of concrete from rust.

3.02 ERECTION

- A. General: In accordance with ACI 301, unless otherwise specified.
- B. Beveled Edges (Chamfer):
 - 1. Form 3/4-inch bevels at concrete edges, unless otherwise shown.
 - 2. Where beveled edges on existing adjacent structures are other than 3/4 inch, obtain Engineer's approval of size prior to placement of beveled edge.
- C. Wall Forms:
 - 1. Do not reuse forms with damaged surfaces.
 - 2. Locate form ties and joints in uninterrupted uniform pattern.
 - 3. Inspect form surfaces prior to installation to ensure conformance with specified tolerances.
- D. Curb, Sidewalk, and Driveway Forms:
 - 1. Provide standard steel or wood forms.
 - 2. Set forms to true lines and grades, and securely stake in position.
- E. Form Tolerances:
 - 1. Provide forms in accordance with ACI 117 and ACI 318, and the following tolerances for finishes specified:
 - a. See the Schedule of Concrete Finishes in Section 03 30 00, Cast-in-Place Concrete, for beam, column, and wall types related to required form tolerances.
 - b. Wall Tolerances:
 - 1) Straight Vertical or Horizontal Wall Surface: Flat planes within tolerance specified.
 - 2) Wall Type W-A:
 - a) Plumb within 1/4 inch in 10 feet or within 1 inch from top to bottom for walls over 40 feet high.
 - b) Depressions in Wall Surface: Maximum 5/16 inch when 10-foot straightedge is placed on high points in all directions.
 - 3) Wall Type W-B:
 - a) Plumb within 1/8 inch in 10 feet or within 1/2 inch from top to bottom for walls over 40 feet high.
 - b) Depressions in Wall Surface: Maximum 1/8 inch when 10-foot straightedge is placed on high points in all directions.

- 4) Thickness: Maximum 1/4 inch minus or 1/2 inch plus from dimension shown.
- 5) Form Offset: Between adjacent pieces of formwork, facing material shall not exceed 1/4 inch.

3.03 FORM REMOVAL

- A. Nonsupporting forms, sides of beams, walls, columns, and similar parts of Work, may be removed after cumulatively curing at not less than 50 degrees F for 24 hours from time of concrete placement if:
 1. Concrete is sufficiently hard so as not to sustain damage by form removal operations.
 2. Curing and protection operations are maintained.
- B. Elevated Structural Slabs or Beams: In accordance with ACI 318, Chapter 6, and at such time as concrete has reached compressive strength equal to 80 percent of specified 28-day compressive strength as determined by test cylinders.
- C. Form Ties: Remove conical inserts or through bolts and plug holes as specified in Section 03 30 00, Cast-in-Place Concrete.

3.04 FIELD QUALITY ASSURANCE AND QUALITY CONTROL

- A. Owner-Furnished Quality Assurance, in accordance with IBC Chapter 17 requirements, is provided in Statement of Special Inspections in Supplement located at end of Section 01 45 33, Special Inspection, Observation, and Testing. Contractor responsibilities and related information are included in Section 01 45 33, Special Inspection, Observation, and Testing.

END OF SECTION

SECTION 03 15 00
CONCRETE JOINTS AND ACCESSORIES

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. ASTM International (ASTM):
 - a. A36/A36M, Specification for Carbon Structural Steel.
 - b. A615/A615M, Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
 - c. A653/A653M, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
 - d. A767/A767M, Specification for Zinc-Coated (Galvanized) Steel Bars for Concrete Reinforcement.
 - e. C920, Specification for Elastomeric Joint Sealants.
 - f. D226, Specification for Asphalt-Saturated Organic Felt Used in Roofing and Waterproofing.
 - g. D227, Specification for Coal-Tar Saturated Organic Felt Used in Roofing and Waterproofing.
 - h. D994, Specification for Preformed Expansion Joint Filler for Concrete (Bituminous Type).
 - i. D1056, Specification for Flexible Cellular Materials—Sponge or Expanded Rubber.
 - j. D1171, Standard Guide for Evaluating Nonwoven Fabrics.
 - k. D1751, Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types).
 - l. D1752, Specification for Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction.
 - m. D2240, Standard Test Method for Rubber Property – Durometer Hardness.
2. Corps of Engineers (COE): CRD-C-572, Corps of Engineers Specifications for Polyvinylchloride Waterstop.

1.02 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
 - a. Waterstop: Details of splices, method of securing and supporting waterstop in forms to maintain proper orientation and location during concrete placement.
 - b. Construction Joints, Expansion Joints and Control Joints: Layout and location for each type. Include joints locations shown on Drawings, additional required joint locations and any proposed alternate locations.
2. Product Data:
 - a. Waterstops.
 - b. Bond breaker.
 - c. Premolded joint fillers.
 - d. Pourable joint fillers.
 - e. Preformed control joints.
 - f. Epoxy-coated dowels.
 - g. Roofing felt.
 - h. Accessories not specified in other sections.
3. Samples: PVC waterstop splice, joint, and fabricated cross of each size, shape, and fitting of waterstop.

B. Informational Submittals:

1. Certification:
 - a. Letter stating compatibility between liquids being contained and materials used for:
 - 1) Waterstops.
 - 2) Joint fillers.
 - b. Manufacturer's application instructions for:
 - 1) Bonding agent.
 - 2) Bond breaker.
2. Manufacturer's written instructions for product shipment, storage, handling, installation/application, and repair for:
 - a. Waterstops.
 - b. Bond breaker.
 - c. Bonding agent.
 - d. Premolded joint fillers.
 - e. Pourable joint fillers (sealant proportions not required as products used only as a filler).
 - f. Preformed control joints.

1.03 DELIVERY, STORAGE, AND HANDLING

- A. Acceptance at Site: Verify delivered materials are in accordance with Specifications, regulatory agencies, and Manufacturer's product data sheets prior to unloading and storing onsite.
- B. Storage: Store materials under tarps to protect from oil, dirt, and sunlight or as required by Manufacturer.

PART 2 PRODUCTS

2.01 PLASTIC WATERSTOP

- A. Extruded from elastomeric plastic compound of which basic resin shall be prime virgin polyvinyl chloride (PVC). Compound shall not contain scrapped material, reclaimed material, or pigment.
- B. Specific Gravity: Approximately 1.37.
- C. Shore Durometer Type A Hardness: Approximately 80.
- D. Performance Requirements: COE Specification CRD-C-572.
- E. Type Required in All Expansion, Contraction, and Control Joints: 6 inches wide or 9 inches wide with center bulb and parallel longitudinal ribs or protrusions on each side of strip center, as indicated on Drawings.
- F. Type Required in Construction Joints: Flat ribbed, 6 inches wide or 9 inches wide with parallel longitudinal ribs or protrusions on each side of strip center. Center bulb is optional.
- G. Corrugated or tapered type waterstops are not acceptable.
- H. Thickness: Constant from bulb edge (or center of waterstop) to outside stop edge.
- I. Minimum Weight per Foot of Waterstop:
 - 1. 0.50 pound for 3/16 inch by 4 inches.
 - 2. 1.60 pounds for 3/8 inch by 6 inches.
 - 3. 2.30 pounds for 3/8 inch by 9 inches.
- J. Factory Fabrications: Use only factory fabrications for intersections, transitions, and changes of direction.

K. Manufacturers and Products for Center Bulb Type:

1. Use same manufacturers for flat ribbed profile:
 - a. Vinylex Corp., St Louis, MO.; No. RB638H (6 inches by 3/8 inch) and No. RB938H (9 inches by 3/8 inch).
 - b. Greenstreak, St. Louis, MO; Style No. 702, (4 inches by 3/16 inch), Style 732 (6 inches by 3/8 inch) and Style 735 (9 inches by 3/8 inch).
 - c. Durajoint, Garrettsville, OH.; Type 3, (4 inches by 3/16 inch), Type 9 (6 inches by 3/8 inch), and Type 10 (9 inches by 3/8 inch).
 - d. BoMetals, Carrollton, GA.: No. RCB-4316LB (4 inches by 3/16 inch), No. RCB-638LB (6 inches by 3/8 inch) and No. RCB-938NT (9 inches by 3/8 inch).
 - e. Dacon Plastics LLC, Jacksonville, TX; No. RCB11, (4 inches by 3/16 inch), No. RCB17 (6 inches by 3/8 inch) and No. RCB18 (9 inches by 3/8 inch).

2.02 WIRE LOOPED PLASTIC WATERSTOP

- A. Furnish as alternative to plastic waterstops.
- B. Same material and geometry as plastic waterstops.
- C. Furnish with continuous galvanized wire looping at edge for convenience in positioning and securing stop in place in forms.
- D. Manufacturer and Product: Paul Murphy Plastics, Roseville, MI; “Wire Stop Waterstop”; geometry numbers ACR 6380, ACR 9380, as shown on Paul Murphy Plastics Co. Drawing No. CCP-120-12M.

2.03 HYDROPHILIC WATERSTOP

- A. For use at construction joints only, where new concrete is placed against existing concrete and as shown on Drawings.
- B. Material shall be a nonbentonite hydrophilic rubber compound.
- C. Manufacturers and Products:
 1. Greenstreak Plastic Products, St. Louis, MO; Hydrotite CJ-1020-2K with Leakmaster LV-1 adhesive and sealant.
 2. Adeka Ultra Seal, JLM Associates, Spearfish, SD; MC-2010M with 3M-2141 adhesive and P-201 sealant.

2.04 BOND BREAKER

- A. Tape for Joints: Adhesive-backed glazed butyl or polyethylene tape. Same width as joint that will adhere to premolded joint material or concrete surface.
- B. Use bond prevention material as specified in Section 03 30 00, Cast-in-Place Concrete, except where bond breaker tape is specifically called for on Drawings.

2.05 PREMOLDED JOINT FILLER

- A. Bituminous Type: ASTM D994 or ASTM D1751.
- B. Sponge Rubber:
 - 1. Neoprene, closed-cell, expanded; ASTM D1056, Type 2C5, with compression deflection, 25 percent deflection (limits), 119 kPa to 168 kPa (17 psi to 24 psi) minimum. Use in joints for potable and nonpotable water containment structures.
 - 2. Manufacturer and Product: Monmouth Rubber and Plastics, Corp, Long Branch, NJ; Durafoam DK5151.

2.06 BUILDING PREFORMED CONTROL JOINT

- A. One-Piece, Flexible, Polyvinyl Chloride Joint Former:
 - 1. Manufacturer and Product: WR Meadows, Inc., Hampshire, IL; Keyway.
- B. One-Piece Galvanized Steel Strip with Preformed Groove:
 - 1. Manufacturer and Product: BoMetals, Inc. Carrollton, GA; QuickKey or ProKey Joint.
- C. Furnish in full-length, unspliced pieces.

2.07 POURABLE JOINT FILLERS

- A. General:
 - 1. Although product is a sealant, it is being specified as a filler to prevent debris accumulation and allow expansion and contraction under shrinkage and thermal loads. It does not need to meet proportional sealant geometry requirements.

B. Filler for Potable or Non-Potable Water Containment Structures:

1. Multicomponent sealant, self-leveling or nonsag as required for level, sloping, or vertical joints.
2. Color: White.
3. Manufacturer and Product: Sika Corp., Lyndhurst, NJ; Sikaflex-2c SL.

2.08 STEEL EXPANSION JOINT DOWELS

A. Dowels: ASTM A36/A36M round smooth steel bars.

B. Bar Coating: As specified in Section 09 90 00, Painting and Coating, with factory-applied epoxy coating and factory or field applied lubrication coating.

2.09 ACCESSORIES

A. Joint Sealant: Polyurethane as specified in Section 07 92 01, Sealants and Caulking.

B. Roofing Felt: ASTM D226, Type II, 30-pound asphalt-saturated or equal weight of ASTM D227 coal-tar saturated felt.

C. Steel Reinforcement: As specified in Section 03 21 00, Steel Reinforcement.

D. Nails: Galvanized, as required for securing premolded joint filler.

E. Galvanized Rebar at Control Joints: ASTM A767/A767M and ASTM A615/A615M Grade 60 prior to galvanizing.

F. Ties for PVC Waterstop: "Hog Rings" or grommets for each edge at 12-inch maximum spacing.

PART 3 EXECUTION

3.01 GENERAL

A. Commence concrete placement after joint preparation is complete.

B. Time Between Concrete Pours: As specified in Section 03 30 00, Cast-in-Place Concrete.

3.02 SURFACE PREPARATION

A. Construction Joints: Prior to placement of abutting concrete, clean contact surface.

1. Remove laitance and spillage from steel reinforcement and dowels.
2. Roughen surface to minimum of 1/4-inch amplitude:

- a. Sandblast after concrete has fully cured.
- b. Water blast after concrete has partially cured.
- c. Green cut fresh concrete with high-pressure water and hand tools.
- 3. Perform cleaning so as not to damage waterstop, if one is present.

B. Construction Joint with Hydrophilic Waterstop:

- 1. Follow hydrophilic waterstop manufacturer's written instructions.
- 2. Clean debris, dirt, dust, and foreign material from concrete surface. Concrete surface must be smooth, clean, and dry. Grind concrete as required.

3.03 INSTALLATION OF WATERSTOPS

A. General:

- 1. Continuous waterstop shall be installed in all construction joints in walls and slabs of water holding basins and channels and in walls of belowgrade structures, unless specifically noted otherwise.
- 2. Join waterstop at intersections to provide continuous seal.
- 3. Center waterstop on joint.
- 4. Secure waterstop in correct position. Tie waterstop to steel reinforcement using grommets, "Hog Rings," or tie wire at maximum spacing of 12 inches. Do not displace waterstop during concrete placement.
- 5. Repair or replace damaged waterstop.
- 6. Place concrete and vibrate to obtain impervious concrete in vicinity of joints.
- 7. Joints in Footings and Slabs:
 - a. Ensure that space beneath horizontal waterstop is completely filled with concrete.
 - b. During concrete placement, make visual inspection of waterstop area.
 - c. Limit concrete placement to elevation of waterstop in first pass, vibrate concrete under waterstop, lift ribbed waterstop to confirm full consolidation without voids, then place remaining concrete to full height of slab.

B. Plastic Waterstops:

- 1. Install in accordance with manufacturer's written instructions.
- 2. Splice in accordance with waterstop manufacturer's written instructions using Teflon-coated thermostatically controlled heating iron at approximately 380 degrees F.
 - a. Allow at least 10 minutes before new splice is pulled or strained in any way.

- b. Finished splices shall provide cross section that is dense and free of porosity with tensile strength of not less than 80 percent of unspliced materials.
 - c. Use only factory made waterstop fabrications for all intersections, changes of directions and transitions.
 - d. Field splice permitted only for straight butt welds.
3. Wire looped plastic waterstop may be substituted for plastic waterstop.

C. Hydrophilic Waterstop:

- 1. Install in accordance with manufacturer's written instructions.
- 2. Provide minimum of 2-1/2 inches of concrete cover over waterstop. When structure has two layers of steel reinforcement, locate centered between layers of steel or as shown.
- 3. Apply adhesive to concrete surface and allow to dry for specified time before applying waterstop strip.
- 4. Lap ends of waterstop strip together at splices and corners and join with sealant.
- 5. Verify that waterstop is anchored firmly in place before placing concrete. Do not allow vibrator to come into contact with waterstop.
- 6. Lap hydrophilic waterstop 2 feet minimum with intersecting plastic waterstops.

3.04 CONTROL JOINT INSTALLATION

- A. Locate epoxy-coated steel reinforcement as shown.
- B. Install waterstop.
- C. Vibrate concrete thoroughly along the joint form to produce a dense, smooth surface. Do not roughen surface.
- D. Install bond breaker to concrete surfaces above and below waterstop.

3.05 PREFORMED CONTROL JOINTS

- A. Use only where specifically shown; do not use in water-holding basins.
- B. Locate slightly below top of slab.
- C. Install in accordance with manufacturer's written instructions in straight, full-length pieces.
- D. Steel Strip Type with Preformed Groove: Brace to withstand pressure of concrete during and after placement using only approved stakes and other secondary installation materials.

3.06 MANUFACTURER'S SERVICES

- A. Provide manufacturer's representative at Site for installation assistance, inspection, and certification of proper installation for products specified.

3.07 FIELD QUALITY ASSURANCE AND QUALITY CONTROL

- A. Owner-Furnished Quality Assurance, in accordance with IBC Chapter 17 requirements, is provided in the Statement of Special Inspections Plan in Supplement located at end of Section 01 45 33, Special Inspection, Observation, and Testing. Contractor responsibilities and related information are included in Section 01 45 33, Special Inspection, Observation, and Testing.
- B. Contractor-Furnished Quality Control: Inspection and testing as required in Section 01 45 16.13, Contractor Quality Control.

END OF SECTION

SECTION 03 21 00
STEEL REINFORCEMENT

PART 1 GENERAL

1.01 GENERAL

- A. Steel reinforcement shall comply with ACI 301 and as modified in the following.

1.02 REFERENCES

- A. The following is a list of standards which may be referenced in this section:
1. American Concrete Institute (ACI):
 - a. 117, Specification for Tolerances for Concrete Construction and Materials.
 - b. 301, Specifications for Structural Concrete.
 - c. SP-66, Detailing Manual.
 2. American Welding Society (AWS): D1.4/D1.4M, Structural Welding Code - Reinforcing Steel.
 3. ASTM International (ASTM):
 - a. A615/A615M, Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
 - b. A706/A706M, Standard Specification for Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement.
 - c. A767/767M, Standard Specification for Zinc-Coated (Galvanized) Steel bars for Concrete Reinforcement
 - d. A1064/A1064M, Standard Specification for Carbon Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete.
 4. Concrete Reinforcing Steel Institute (CRSI):
 - a. Placing Reinforcing Bars.
 - b. Manual of Standard Practice.
 5. International Code Council (ICC): Evaluation Services Report.

1.03 SUBMITTALS

- A. Action Submittals:
1. Shop Drawings prepared in accordance with ACI 301 and ACI SP-66:
 - a. Bending lists.
 - b. Placing drawings.
 2. Welded, metallic sleeve splice, and mechanical threaded connection.

B. Informational Submittals:

1. Lab test reports for steel reinforcement showing stress-strain curves and ultimate strengths.
2. Mechanical Threaded Connections:
 - a. Current ICC Evaluation Services Report or equivalent code agency report listing findings to include acceptance, special inspection requirements, and restrictions.
 - b. Verification device threads have been tested and meet requirements for thread quality, in accordance with manufacturer's published methods.
 - c. Manufacturer's instructions.
3. Test results of field testing.

1.04 DELIVERY, STORAGE, AND HANDLING

- A. In accordance with ACI 301 and recommendations of CRSI Placing Reinforcing Bars.

PART 2 PRODUCTS

2.01 MATERIALS

A. Reinforcing Bars:

1. Includes stirrups, ties, and spirals.
2. ASTM A615/A615M, Grade 60, where welding is not required.
3. ASTM A706/A706M, Grade 60, for reinforcing to be welded.
4. ASTM A767/767M, Grade 60, for galvanized bars.

B. Mechanical Splices and Connections:

1. Metal Sleeve Splice:
 - a. Furnish with cast filler metal, capable of developing, in tension or compression, 125 percent of minimum tensile strength of bar.
 - b. Manufacturer and Product: Erico Products, Inc., Cleveland, OH; Cadweld T-Series.
2. Mechanical Threaded Connections:
 - a. Furnish metal coupling sleeve with internal threads engaging threaded ends of bars developing in tension or compression 125 percent of yield strength of bar.
 - b. Manufacturers and Products:
 - 1) Erico Products, Inc., Cleveland, OH; Lenton Reinforcing Steel Couplers.
 - 2) Erico Products, Inc., Cleveland, OH; Lenton Lock Mechanical Rebar Splicing System.

- 3) Richmond Screw Anchor Co., Inc., Fort Worth, TX;
Richmond DB-SAE Dowel Bar Splicers.

C. Welded Wire Fabric:

1. ASTM A1064, using wire of 75 ksi minimum tensile strength.
2. Furnish flat sheets only, rolled sheets not permitted.

2.02 ACCESSORIES

A. Tie Wire:

1. Black, soft-annealed 16-gauge wire.
2. Nylon-, epoxy-, or plastic-coated wire.

B. Bar Supports and Spacers:

1. Use all-plastic or stainless steel side form spacers, unless noted otherwise. Do not use other types of supports or spacers.
2. Bar supports shall have sufficient strength and stiffness to carry loads without failure, displacement, or significant deformation. Space bar supports so minimum concrete cover is maintained for reinforcing between supports.
3. Use only precast concrete bar supports where concrete surfaces are exposed to weather, earth, water, chloride intrusion, or corrosive chemicals. Bar supports shall be nonconductive and have geometry and bond characteristics that deter movement of moisture from the surface to the reinforcement.
4. Precast concrete supports shall have same minimum strength and shall be made from same materials as that of the concrete in which they are to be embedded. Precast concrete supports shall be cast and properly cured for at least 7 days before use and shall have a wire or other device cast into each block for the purpose of attaching them securely to steel reinforcement.
5. Design and fabricate special bar supports for top reinforcing bars in slabs where standard bar supports do not possess necessary geometry, strength, or stiffness.
6. Plastic Bar Supports: Manufactured by Aztec Concrete Accessories, Bloomington, CA.
7. Precast Concrete Supports:
 - a. Total bond precast, high-performance concrete bar supports as supplied by:
 - 1) Dayton Superior, Miamisburg, OH, Dobies.

PART 3 EXECUTION

3.01 PREPARATION

- A. Notify Engineer when reinforcing is ready for inspection and allow sufficient time for inspection prior to placing concrete.
- B. Clean reinforcing bars of loose mill scale, oil, earth, and other contaminants.
- C. Coat wire projecting from precast concrete bar supports with dielectric material, epoxy, or plastic.

3.02 INSTALLATION

- A. Bundle or space bars, instead of field bending where construction access through reinforcing is necessary.
- B. Splicing:
 - 1. Minimum length of lap splices shall comply with table in Contract Documents.
 - 2. Use lap splices, unless otherwise shown or permitted in writing by Engineer.
 - 3. Welded Splices: Accomplish by full penetration groove welds and develop a minimum of 125 percent of yield strength of bar.
 - 4. Stagger splices in adjacent bars where indicated.
- C. Mechanical Splices and Connections:
 - 1. Use only in areas specifically approved in writing by Engineer.
 - 2. Install threaded rods as recommended by manufacturer with threads totally engaged into coupling sleeve and in accordance with ICC Evaluation Services Report or equivalent code agency report.
 - 3. For metal sleeve splice, follow manufacturer's installation recommendations.
 - 4. Maintain minimum edge distance and concrete cover.
- D. Tying Reinforcing Bars:
 - 1. Tie every other intersection on mats made up of Nos. 3, 4, 5, and 6 bars to hold them firmly at required spacing.
 - 2. Bend tie wire away from concrete surface to provide clearance of 1 inch from surface of concrete to tie wire.

- E. Reinforcement Around Openings: On each side and above and below pipe or opening, place an equivalent area of steel bars to replace steel bars cut for opening. Extend steel reinforcing a standard lap length beyond opening at each end.
- F. Straightening and Rebending: Field bending of steel reinforcement bars is not permitted.
- G. Unless permitted by Engineer, do not cut reinforcing bars in field.

3.03 WELDED WIRE FABRIC INSTALLATION

- A. Use only where specifically shown.
- B. Extend fabric to within 2 inches of edges of slab and lap splices at least 1-1/2 courses of fabric or minimum 8 inches.
- C. Tie laps and splices securely at ends and at least every 24 inches with tie wire.
- D. Place welded wire fabric on concrete blocks and rigidly support equal to that provided for reinforced bars. Do not use broken concrete, brick, or stone.
- E. Do not use fabric that has been rolled. Install flat sheets only.

3.04 FIELD QUALITY ASSURANCE AND QUALITY CONTROL

- A. Owner-Furnished Quality Assurance, in accordance with IBC Chapter 17 requirements, is provided in the Statement of Special Inspections Plan in Supplement located at end of Section 01 45 33, Special Inspection, Observation, and Testing. Contractor responsibilities and related information are included in Section 01 45 33, Special Inspection, Observation, and Testing.
- B. Contractor-Furnished Quality Control: Inspection and testing as required in Section 01 45 16.13, Contractor Quality Control.

END OF SECTION

SECTION 03 30 00 CAST-IN-PLACE CONCRETE

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards that may be referenced in this section:

1. American Concrete Institute (ACI):
 - a. 117, Specification for Tolerances for Concrete Construction and Materials.
 - b. 301, Specifications for Structural Concrete.
 - c. 305.1, Specification for Hot Weather Concreting.
 - d. 306.1, Standard Specification for Cold Weather Concreting.
 - e. 350.1, Specification for Tightness Testing of Environmental Engineering Concrete Containment Structures.
 - f. CP-1, Technical Workbook for ACI Certification of Concrete Field Testing Technician – Grade 1.
2. ASTM International (ASTM):
 - a. C31/C31M, Standard Practice for Making and Curing Concrete Test Specimens in the Field.
 - b. C33/C33M, Standard Specification for Concrete Aggregates.
 - c. C39/C39M, Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.
 - d. C94/C94M, Standard Specification for Ready-Mixed Concrete.
 - e. C109/C109M, Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or [50-mm] Cube Specimens).
 - f. C143/C143M, Standard Test Method for Slump of Hydraulic-Cement Concrete.
 - g. C150/C150M, Standard Specification for Portland Cement.
 - h. C157/C157M, Standard Test Method for Length Change of Hardened Hydraulic-Cement Mortar and Concrete.
 - i. C227, Standard Test Method for Potential Alkali Reactivity of Cement-Aggregate Combinations (Mortar-Bar Method).
 - j. C231/C231M, Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method.
 - k. C260/C260M, Standard Specification for Air-Entraining Admixtures for Concrete.
 - l. C494/C494M, Standard Specification for Chemical Admixtures for Concrete.
 - m. C595/C595M, Standard Specification for Blended Hydraulic Cements.

- n. C618, Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete.
 - o. C881/C881M, Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete.
 - p. C989, Standard Specification for Slag Cement for Use in Concrete and Mortars.
 - q. C1012/C1012M, Standard Test Method for Length Change of Hydraulic-Cement Mortars Exposed to a Sulfate Solution.
 - r. C1017/C1017M, Standard Specification for Chemical Admixtures for Use in Producing Flowing Concrete.
 - s. C1074, Standard Practice for Estimating Concrete Strength by the Maturity Method.
 - t. C1077, Standard Practice for Agencies Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Testing Agency Evaluation.
 - u. C1218/C1218M, Standard Test Method for Water-Soluble Chloride in Mortar and Concrete.
 - v. C1240, Standard Specification for Silica Fume Used in Cementitious Mixtures.
 - w. C1260, Standard Test Method for Potential Alkali Reactivity of Aggregates (Mortar-Bar Method).
 - x. C1293, Standard Test Method for Determination of Length Change of Concrete Due to Alkali-Silica Reaction.
 - y. C1567, Standard Test Method for Determining the Potential Alkali-Silica Reactivity of Combinations of Cementitious Materials and Aggregate (Accelerated Mortar-Bar Method).
 - z. C1582/C1582M, Standard Specification for Admixtures to Inhibit Chloride-Induced Corrosion of Reinforcing Steel in Concrete.
 - aa. C1602/C1602M, Standard Specification for Mixing Water Used in the Production of Hydraulic Cement Concrete.
 - bb. E329, Standard Specification for Agencies Engaged in Construction Inspection, Special Inspection, or Testing Materials.
3. National Ready Mixed Concrete Association (NRMCA).

1.02 DEFINITIONS

- A. Cold Weather: When ambient temperature is below 40 degrees F or is approaching 40 degrees F and falling.
- B. Contractor's Licensed Design Engineer: Individual representing Contractor who is licensed to practice engineering as defined by statutory requirements of professional licensing laws in state or jurisdiction in which Project is to be constructed.

- C. Defective Area: Surface defects that include honeycomb, rock pockets, indentations, and surface voids greater than 3/16-inch deep, surface voids greater than 3/4 inch in diameter, cracks in liquid containment structures and below grade habitable spaces that are 0.005-inch wide and wider, and cracks in other structures that are 0.010-inch wide and wider, spalls, chips, embedded debris, sand streaks, mortar leakage from form joints, deviations in formed surface that exceed specified tolerances and include but are not limited to fins, form pop-outs, and other projections. At exposed concrete, defective areas also include texture irregularities, stains, and other color variations that cannot be removed by cleaning.
- D. Exposed Concrete: Concrete surface that can be seen inside or outside of structure regardless of whether concrete is above water, dry at all times, or can be seen when structure is drained.
- E. Hot Weather: As defined in ACI 305.1.
- F. Hydraulic Structure: Liquid containment structure.
- G. New Concrete: Less than 60 days old.

1.03 SUBMITTALS

A. Action Submittals:

- 1. Mix Designs:
 - a. Contain proportions of materials and admixtures to be used on Project, signed by mix designer.
 - b. Documentation of average strength for each proposed mix design in accordance with ACI 301.
 - c. Manufacturer's Certificate of Compliance, in accordance with Section 01 61 00, Common Product Requirements, for the following:
 - 1) Portland cement.
 - 2) Fly ash.
 - 3) Slag cement.
 - 4) Aggregates, including specified class designation for coarse aggregate.
 - 5) Admixtures.
 - 6) Concrete producer has verified compatibility of constituent materials in design mix.
 - d. Test Reports: Water-Soluble Chloride-Ion Content in Hardened Concrete: Unless otherwise permitted, in accordance with ASTM C1218/C1218M at an age between 28 days and 42 days.

- e. Aggregates:
 - 1) Percent of fine aggregate weight to total aggregate weight.
 - 2) Deleterious substances in fine aggregate per ASTM C33/C33M, Table 2.
 - 3) Deleterious substances in coarse aggregate per ASTM C33/C33M, Table 4.
 - 4) Test Reports:
 - a) Alkali Aggregate Reactivity: Aggregate shall be classified as nonpotentially reactive in accordance with Article Concrete Mix Design. Include documentation of test results per applicable standards.
- f. Admixtures: Manufacturer's catalog cut sheets and product data sheets for each admixture used in proposed mix designs.
- 2. Product Data: Specified ancillary materials.
- 3. Detailed plan for curing and protection of concrete placed and cured in cold weather. Details shall include, but not be limited to, the following:
 - a. Procedures for protecting subgrade from frost and accumulation of ice or snow on reinforcement, other metallic embeds, and forms prior to placement.
 - b. Procedures for measuring and recording temperatures of reinforcement and other embedded items prior to concrete placement.
 - c. Methods for temperature protection during placement.
 - d. Types of covering, insulation, housing, or heating to be provided.
 - e. Curing methods to be used during and following protection period.
 - f. Use of strength accelerating admixtures.
 - g. Methods for verification of in-place strength.
 - h. Procedures for measuring and recording concrete temperatures.
 - i. Procedures for preventing drying during dry, windy conditions.
- 4. Detailed plan for hot weather placements including curing and protection for concrete placed in ambient temperatures over 80 degrees F. Plan shall include, but not be limited to, the following:
 - a. Procedures for measuring, and recording temperatures of reinforcement and other embedded items prior to concrete placement.
 - b. Use of retarding admixture.
 - c. Methods for controlling temperature of reinforcement and other embedded items and concrete materials before and during placement.
 - d. Types of shading and wind protection to be provided.
 - e. Curing methods, including use of evaporation retardant.
 - f. Procedures for measuring and recording concrete temperatures.
 - g. Procedures for preventing drying during dry, windy conditions.

B. Informational Submittals:

1. Preinstallation Conference minutes.
2. Manufacturer's application instructions for bonding agent and bond breaker.
3. Manufacturer's Certificate of Compliance to specified standards: Bonding agent.
4. Statement of Qualification:
 - a. Batch Plant: Certification as specified herein.
 - b. Mix designer.
 - c. Installer.
 - d. Testing agency.
5. Field test reports.
6. Tightness test results.
7. Concrete Delivery Tickets:
 - a. For each batch of concrete before unloading at Site.
 - b. In accordance with ASTM C94/C94M, including requirements 14.2.1. through 14.2.10.
 - c. Indicate amount of mixing water withheld and maximum amount that may be permitted to be added at Site.

1.04 QUALITY ASSURANCE

A. Concrete construction shall conform to requirements of ACI 117 and ACI 301, except as modified herein.

B. Qualifications:

1. Batch Plant: NRMCA Program for Certification of Ready-Mixed Concrete Production Facilities or approved equivalent program.
2. Mix Designer: Person responsible for developing concrete mixture proportions certified as NRMCA Concrete Technologist Level 2 or DOT certified mix designer in jurisdiction of the Work. Requirement may be waived if individual is Contractor's Licensed Design Engineer.
3. Testing Agency: Unless otherwise permitted, an independent agency, acceptable to authorities having jurisdiction, qualified according to ASTM C1077 and ASTM E329 for testing indicated.
 - a. Where field testing is required of Contractor, personnel conducting field tests shall be qualified as ACI Concrete Field Testing Technician, Grade 1, according to ACI CP-1 or an equivalent certification program.
 - b. Personnel performing laboratory tests shall be ACI-certified Concrete Strength Testing Technician and Concrete Laboratory Testing Technician - Grade I. Testing Agency laboratory supervisor shall be an ACI-certified Concrete Laboratory Testing Technician - Grade II.

C. Preinstallation Conference:

1. Required Meeting Attendees:
 - a. Contractor, including pumping, placing and finishing, and curing subcontractors.
 - b. Ready-mix producer.
 - c. Admixture representative.
 - d. Testing and sampling personnel.
 - e. Engineer who authored Statement of Special Inspection Plan or Engineer's designee.
2. Schedule and conduct prior to incorporation of respective products into Project. Notify Engineer of location and time.
3. Agenda shall include:
 - a. Admixture types, dosage, performance, and redosing at Site.
 - b. Mix designs, test of mixes, and Submittals.
 - c. Placement methods, techniques, equipment, consolidation, and form pressures.
 - d. Slump and placement time to maintain slump.
 - e. Finish, curing, and water retention.
 - f. Protection procedures for weather conditions.
 - g. Other specified requirements requiring coordination.
4. Conference minutes as specified in Section 01 31 19, Project Meetings.

PART 2 PRODUCTS

2.01 MATERIALS

A. Cementitious Materials:

1. Cement:
 - a. Portland Cement: Unless otherwise specified, conform to requirements of ASTM C150/C150M.
 - b. Blended Hydraulic Cement:
 - 1) Unless otherwise specified, conform to requirements of ASTM C595/C595M.
 - 2) Portland cement used in blended hydraulic cement, conform to requirements of ASTM C150/C150M.
 - c. Furnish from one source.
2. Supplementary Cementitious Materials (SCM):
 - a. Fly Ash (Pozzolan): Class F fly ash in accordance with ASTM C618, except as modified herein:
 - 1) Shall not be produced from process that has utilized hazardous or potentially hazardous materials.
 - 2) ASTM C618, Table 1, Loss on Ignition: Unless permitted otherwise, maximum 3 percent.

- b. Slag Cement: In accordance with ASTM C989, Grade 100 or Grade 120.
 - 1) Shall not be produced from process that has utilized hazardous or potentially hazardous materials.
- B. Aggregates: Furnish from one source for each aggregate type used in a mix design.
 - 1. Normal-Weight Aggregates:
 - a. In accordance with ASTM C33/C33M, except as modified herein.
 - 1) Class Designation: 4S unless otherwise specified.
 - b. Free of materials and aggregate types causing popouts, discoloration, staining, or other defects on surface of concrete.
 - c. Alkali Silica Reactivity: See Article Concrete Mix Design.
 - 2. Fine Aggregates:
 - a. Clean, sharp, natural sand.
 - b. ASTM C33/C33M.
 - c. Limit deleterious substances in accordance with ASTM C33/C33M, Table 2 and as follows:
 - 1) Limit material finer than 75- μ m (No. 200) sieve to 5 percent mass of total sample.
 - 2) Limit coal and lignite to 1.0 percent.
 - 3. Coarse Aggregate:
 - a. Natural gravels, combination of gravels and crushed gravels, crushed stone, or combination of these materials containing no more than 15 percent flat or elongated particles (long dimension more than five times the short dimension).
 - b. Limit deleterious substances in accordance with ASTM C33/C33M, Table 4 for specified class designation.
- C. Admixtures: Unless otherwise permitted, furnish from one manufacturer.
 - 1. Characteristics:
 - a. Compatible with other constituents in mix.
 - b. Contain at most, only trace amount chlorides in solution.
 - c. Furnish type of admixture as recommended by manufacturer for anticipated temperature ranges.
 - 2. Air-Entraining Admixture: ASTM C260/C260M.
 - 3. Water-Reducing Admixture: ASTM C494/C494M, Type A or Type D.
 - 4. Retarding Admixture: ASTM C 494/C 494M, Type B.
 - 5. Accelerating Admixture: ASTM C 494/C 494M, Type C.
 - 6. High-Range, Water-Reducing Admixture: ASTM C494/C494M, Type F or Type G.
 - a. Manufacturers and Products:
 - 1) BASF Admixtures Inc., Shakopee, MN; Glenium Series, PS 1460, or Rheobuild 1000.

- 2) Euclid Chemical Co., Cleveland, OH; Eucon Series or Plastol Series.
- 3) W. R. Grace & Co., Cambridge, MA; ADVA Series, Daracem Series, or EXP 950.
7. Plasticizing Admixture: ASTM C1017/C1017M, Type I or Type II.
8. Do not use calcium chloride as an admixture.
9. Admixtures with no standard, ASTM or other, designation may be used where permitted.

D. Water and Ice: Mixing water for concrete and water used to make ice shall be potable.

2.02 ANCILLARY MATERIALS

A. Bonding Agent: Unless otherwise specified, in accordance with the following:

1. ASTM C881/C881M, Type V.
2. Two-component, moisture insensitive, 100 percent solids epoxy.
3. Consult manufacturer for surface finish, pot life, set time, vertical or horizontal application, and forming restrictions.
4. Manufacturers and Products:
 - a. BASF Building Systems Inc., Shakopee, MN; Concrecive Standard LVI.
 - b. Euclid Chemical Co., Cleveland, OH; Euco # 352 Epoxy System LV.
 - c. Prime Resins, Conyers, GA; Prime Bond 3000 to 3900 Series.

B. Bond Breaker:

1. Nonstaining type, providing positive bond prevention.
2. Manufacturers and Products:
 - a. Dayton Superior Corporation, Kansas City, KS; EDOCO Clean Lift Bond Breaker.
 - b. Nox-Crete Products Group, Omaha, NE; Silcoseal Select.

C. Repair Material:

1. In accordance with requirements of Section 03 01 32, Repair of Vertical and Overhead Concrete Surfaces.
2. In accordance with requirements of Section 03 01 33, Repair of Horizontal Concrete Surfaces.

D. Crack Repair: In accordance with requirements of Section 03 64 23, Crack Repair Epoxy Injection Grouting.

2.03 CONCRETE MIX DESIGN

A. General:

1. See Supplement at the end of this section for mix design requirements for each class of concrete used on Project.
2. Prepare design mixtures for each type and strength of concrete, selecting and proportioning ingredients in accordance with requirements of ACI 301, unless otherwise specified.
3. Selection of constituent materials and products in mix design are optional, unless specified otherwise.
4. Unless otherwise permitted, use water-reducing admixture or water-reducing admixture and high-range, water-reducing admixture in pumped concrete, in concrete with a water-cementitious materials ratio below 0.50, and in concrete that is part of a liquid-containment structure.
5. Unless otherwise permitted, use water-reducing admixture and high-range, water-reducing admixture in piers, pilasters, and walls.
6. Use water-reducing admixture or high-range, water-reducing admixture to achieve fresh properties that facilitate handling, placing, and consolidating of concrete, and specified hardened properties.
7. Use water-reducing and retarding admixture when anticipated high temperatures, low humidity, or other adverse placement conditions can adversely affect fresh properties of concrete.
8. Unless otherwise specified, desired fresh properties of concrete shall be determined by Contractor, and coordinated with concrete producer. Fresh properties of concrete shall remain stable to satisfaction of Contractor, for duration of placement and consolidation, and shall remain in conformance with requirements of Contract Documents.
9. Contractor is encouraged to consider using environmentally sustainable concrete mix design technologies such as use of supplementary cementitious materials and aggregate packing.

B. Potential alkali-aggregate reactivity of concrete:

1. Do not use aggregates known to be susceptible to alkali-carbonate reaction (ACR).
2. Aggregates shall have been tested to determine potential alkali-aggregate reactivity in concrete in accordance with ASTM C1260 or ASTM C1567.
 - a. Aggregates that indicate expansion greater than 0.10 percent at 16 days after casting shall not be used unless they have been shown to be nondeleteriously reactive in accordance with ASTM C227 or ASTM C1293, with less than 0.04 percent expansion at 1 year for cement-aggregate combinations or less

than 0.04 percent expansion at 2 years for combinations with pozzolan or slag.

- b. Alkali content of cement used in proposed concrete mixture shall not be greater than alkali content of cement used in test for potential alkali-aggregate reactivity.

C. Proportions:

- 1. Design mix to meet aesthetic, durability, and strength requirements.
- 2. Where fly ash is included in mix, minimum fly ash content shall be a minimum of 15 percent of weight of total cementitious materials.

D. Slump Range at Site:

- 1. Prior to submitting mix design, consult with concrete producer and select a target slump value at point of delivery, for each application of each design mix. Unless otherwise permitted, target slump value will then be enforced for duration of Project.
- 2. Design mixes that include a high-range, water-reducing admixture shall have a minimum slump of 2 inches prior to addition of admixture. Unless otherwise permitted, slump shall be 8 inches maximum at point of delivery, for concrete with a high-range, water-reducing admixture.
- 3. Slump tolerance shall meet requirements of ACI 117.

2.04 CONCRETE MIXING

A. General: In accordance with ACI 301, except as modified herein.

B. Truck Mixers:

- 1. For every truck, test slump of samples taken per ASTM C94/C94M, paragraph 12.5.1.
- 2. Where specified slump is more than 4 inches, and if slump tests differ by more than 2 inches, discontinue use of truck mixer, unless causing condition is corrected and satisfactory performance is verified by additional slump tests.

2.05 SOURCE QUALITY CONTROL

A. Source Quality Control Inspection: Engineer shall have access to and have right to inspect batch plants, cement mills, and supply facilities of suppliers, manufacturers, and Subcontractors, providing products included in this section.

PART 3 EXECUTION**3.01 PLACING CONCRETE**

- A. Preparation: Meet requirements ACI 301, except as modified herein.
- B. Inspection: Notify Engineer and Special Inspector at least 1 full working day in advance before starting to place concrete.
- C. Placement into Formwork:
 - 1. Where vapor retarder or barrier is required, coordinate subgrade preparation with requirements in Division 07 of Specifications.
 - 2. Reinforcement: Secure in position before placing concrete.
 - 3. Place concrete as soon as possible after leaving mixer, without segregation or loss of ingredients, without splashing forms or steel above, and in layers not over 1.5 feet deep, except for slabs which shall be placed full depth. Place and consolidate successive layers prior to initial set of first layer to prevent cold joints.
 - 4. Placement frequency shall be such that lift lines will not be visible in exposed concrete finishes.
 - 5. Use placement devices, for example chutes, pouring spouts, and pumps as required to prevent segregation.
 - 6. Vertical Free Fall Drop to Final Placement:
 - a. Forms 8 Inches or Less Wide: 5 feet.
 - b. Forms Wider than 8 Inches: 8 feet, except as specified.
 - 7. For placements where drops are greater than specified, use placement device such that free fall below placement device conforms to required value.
 - a. Limit free fall to prevent segregation caused by aggregates hitting steel reinforcement.
 - 8. Do not use aluminum conveying devices.
 - 9. Provide sufficient illumination in the interior of forms so concrete deposition is visible, permitting confirmation of consolidation quality.
 - 10. Joints in Footings and Slabs:
 - a. Ensure space beneath plastic waterstop completely fills with concrete.
 - b. During concrete placement, make visual inspection of entire waterstop area.
 - c. Limit concrete placement to elevation of waterstop in first pass, vibrate concrete under waterstop, lift waterstop to confirm full consolidation without voids, and place remaining concrete to full height of slab.
 - d. Apply procedure to full length of waterstop.
 - 11. Trowel and round off top exposed edges of walls with 1/4-inch radius steel edging tool.

12. Cure concrete as specified in Section 03 39 00, Concrete Curing.

D. Conveyor Belts and Chutes:

1. Design and arrange ends of chutes, hopper gates, and other points of concrete discharge throughout conveying, hoisting, and placing system for concrete to pass without becoming segregated.
2. Do not use chutes longer than 50 feet.
3. Minimum Slopes of Chutes: Angled to allow concrete to readily flow without segregation.
4. Conveyor Belts:
 - a. Approved by Engineer.
 - b. Wipe clean with device that does not allow mortar to adhere to belt.
 - c. Cover conveyor belts and chutes.

E. Retempering: Not permitted for concrete where cement has partially hydrated.

F. Pumping of Concrete:

1. Provide standby pump, conveyor system, crane and concrete bucket, or other system onsite during pumping, for adequate redundancy to ensure completion of concrete placement without cold joints in case of primary placing equipment breakdown.
2. Minimum Pump Hose (Conduit) Diameter: 4 inches.
3. Replace pumping equipment and hoses (conduits) that are not functioning properly.

G. Maximum Size of Concrete Placements:

1. Limit size of each placement to allow for strength gain and volume change as a result of shrinkage.
2. Locate expansion, control, and contraction joints where shown on Drawings.
3. Construction Joints: Unless otherwise shown or permitted, locate construction joints as follows:
 - a. Locate construction joints as shown on Drawings or where approved in joint location submittal required in Section 03 15 00, Concrete Joints and Accessories.
 - b. Provide vertical construction joints in walls and slabs at maximum spacing of 40 feet, unless shown or approved otherwise.
 - c. When vertical expansion, contraction, or control joint spacing does not exceed 60 feet, intermediate construction joints are not required.
 - d. Uniformly space vertical construction joints within straight sections of walls and slabs, avoiding penetrations.

4. Should placement sequence result in cold joint located below finished water surface, install waterstop in joint.

H. Minimum Time between Adjacent Placements:

1. Construction or Control Joints: 7 days unless otherwise specified.
2. Construction joint between top of footing or slab, and column or wall:
As soon as can safely be done without damaging previously cast concrete or interrupting curing thereof, but not less than 24 hours.
3. Expansion or Contraction Joints: 1 day.

I. Consolidation and Visual Observation:

1. Consolidation Equipment and Methods: ACI 301.
2. Provide at least one standby vibrator in operable condition at Site prior to placing concrete.
3. Provide sufficient windows in forms or limit form height to allow for concrete placement through windows and for visual observation of concrete.
4. Vibrate concrete in vicinity of joints to obtain impervious concrete.

J. Hot Weather:

1. Prepare ingredients, mix, place, cure, and protect in accordance with ACI 301, ACI 305.1, and as follows:
 - a. Maintain concrete temperature below 90 degrees F at time of placement, or furnish test data or other proof that admixtures and mix ingredients do not produce flash set plastic shrinkage, or cracking as a result of heat of hydration. Cool ingredients before mixing to maintain fresh concrete temperatures as specified or less.
 - b. Provide for windbreaks, shading, fog spraying, sprinkling, ice, wet cover, or other means as necessary to maintain concrete at or below specified temperature.
2. Concrete Curing: As specified in Section 03 39 00, Concrete Curing.

K. Cold Weather Placement:

1. Unless otherwise permitted, shall be in accordance with requirements of ACI 306.1 and as follows:
 - a. Cold weather requirements shall apply when ambient temperature is below 40 degrees F or approaching 40 degrees F and falling.
 - b. Do not place concrete over frozen earth or against surfaces with frost or ice present. Frozen earth shall be thawed to acceptance of Engineer.

- c. Unless otherwise permitted, do not place concrete in contact with surfaces less than 35 degrees F; requirement is applicable to all surfaces including reinforcement and other embedded items.
- d. Provide supplemental external heat as needed when other means of thermal protection are unable to maintain minimum surface temperature of concrete as specified in ACI 306.1.
- e. Maintain minimum surface temperature of concrete as specified in ACI 306.1 for no less than 3 days during cold weather conditions.
- f. Cure concrete as specified in Section 03 39 00, Concrete Curing.
 - 1) Protect concrete from freezing until end of curing period and until concrete has attained a compressive strength of 3,500 psi or design compressive strength if less than 3,500 psi.
- 2. Provide maximum and minimum temperature sensors placed on concrete surfaces spaced throughout Work to allow monitoring of concrete surface temperatures representative of Work. Unless otherwise permitted, record surface temperature of concrete at least once every 12 hours during specified curing period.
- 3. External Heating Units: Do not exhaust heater flue gases directly into enclosed area as it causes concrete carbonation as a result of concentrated carbon dioxide.
- 4. Maintain curing conditions as specified in Section 03 39 00, Concrete Curing.

3.02 CONCRETE BONDING

- A. Construction Joints in New Concrete Members: Prepare surface of construction joint as specified in Section 03 15 00, Concrete Joints and Accessories.
- B. Construction Joints at Existing Concrete:
 - 1. Thoroughly clean and mechanically roughen existing concrete surfaces to roughness profile of 1/4 inch.
 - 2. Saturate surface with water for 24 hours prior to placing new concrete.

3.03 REPAIRING CONCRETE

- A. General:
 - 1. Inject structural cracks that leak with crack repair epoxy as specified in Section 03 64 23, Crack Repair Epoxy Injection Grouting.
 - 2. Inject non-structural cracks that leak with crack repair material as specified in Section 03 64 24, Polyurethane Injection Grouting.
 - 3. Repair defective areas of concrete.

4. Repair horizontal concrete surfaces in accordance with Section 03 01 33, Repair of Horizontal Concrete Surfaces.
5. Repair vertical and overhead concrete surfaces in accordance with Section 03 01 32, Repair of Vertical and Overhead Concrete Surfaces.

B. Tie Holes:

1. Unless otherwise specified, fill with specified repair material.
 - a. Prepare substrate and mix, place, and cure repair material per manufacturer's written recommendations.

C. Exposed Metal Objects:

1. Remove metal objects not intended to be exposed in as-built condition of structure including wire, nails, and bolts, by chipping back concrete to depth of 1 inch and then cutting or removing metal object.
2. Repair area of chipped-out concrete as specified for defective areas.

D. Blockouts at Pipes or Other Penetrations: Where shown install in accordance with requirements of Drawings.

3.04 CONCRETE WALL FINISHES

A. Type W-1 (Ordinary Wall Finish):

1. Patch tie holes.
2. Knock off projections.
3. Repair defective areas.
4. Inject cracks in accordance with requirements of Section 03 64 23, Crack Repair Epoxy Injection Grouting.

B. Type W-2 (Smooth Wall Finish):

1. Patch tie holes.
2. Grind off fins and other projections.
3. Repair defective areas to provide smooth uniform appearance.
4. Inject cracks in accordance with requirements of Section 03 64 23, Crack Repair Epoxy Injection Grouting.

C. Type W-5 (Finish for Painting):

1. In accordance with requirements for Type W-2 except as follows:
 - a. Leave surface ready for painting as specified in Section 09 90 00, Painting and Coating.

3.05 CONCRETE SLAB FINISHES

A. General:

1. Use manual screeds, vibrating screeds, or roller compacting screeds to place concrete level and smooth.
2. Do not use “jitterbugs” or other special tools designed for purpose of forcing coarse aggregate away from surface and allowing layer of mortar, which will be weak and cause surface cracks or delamination, to accumulate.
3. Finish slab in accordance with specified slab finish.
4. Do not dust surfaces with dry materials nor add water to surfaces.
5. Cure concrete as specified in Section 03 39 00, Concrete Curing.

B. Type S-1 (Steel Troweled Finish):

1. Finish by screeding and floating with straightedges to bring surfaces to required finish elevation.
2. Wood float to true, even plane with no coarse aggregate visible.
3. Use sufficient pressure on wood floats to bring moisture to surface.
4. After surface moisture has disappeared, hand steel trowel concrete to produce smooth, smooth dense surface, free from trowel marks.
5. Provide light steel-troweled finish (two trowelings) at air-entrained slabs. Provide hard steel-troweled finish (ringing sound from the trowel) for nonair-entrained slabs.
6. Do not use dry cement or additional water during troweling, nor will excessive troweling be permitted.
7. Power Finishing:
 - a. Approved power machine may be used in lieu of or in addition to hand finishing in accordance with directions of machine manufacturer.
 - b. Do not use power machine when concrete has not attained necessary set to allow finishing without introducing high and low spots in slab.
 - c. Do first steel troweling for slab S-1 finish by hand.

C. Type S-2 (Wood Float Finish):

1. Finish slab to receive fill and mortar setting bed by screeding with straightedges to bring surface to required finish plane.
2. Wood float finish to compact and seal surface.
3. Remove laitance and leave surface clean.
4. Coordinate with other finish procedures.

D. Type S-5 (Broomed Finish):

1. Finish as specified for Type S-1 floor finish, except use only a light-steel troweled finish, and then finish surface by drawing fine-hair broom lightly across surface.
2. Broom in same direction and parallel to expansion joints, or, in case of inclined slabs, perpendicular to slope, except for round roof slab, broom surface in radial direction.

E. Type S-6 (Sidewalk Finish):

1. Slope walks down 1/4 inch per foot away from structures, unless otherwise shown.
2. Strike off surface by means of strike board and float with wood or cork float to true plane, then flat steel trowel before brooming.
3. Broom surface at right angles to direction of traffic or as shown.
4. Lay out sidewalk surfaces in blocks, as shown or as directed by Engineer, with grooving tool.

F. Concrete Curbs:

1. Float top surface of curb smooth, and finish all discontinuous edges with steel edger.
2. After concrete has taken its initial set, remove front form and give exposed vertical surface an ordinary wall finish, Type W-1.

3.06 CONCRETE SLAB TOLERANCES

A. Slab Tolerances:

1. Exposed Slab Surfaces: Comprise of flat planes as required within tolerances specified.
2. Slab Finish Tolerances and Slope Tolerances: Crowns on floor surface not too high as to prevent 10-foot straightedge from resting on end blocks, nor low spots that allow block of twice the tolerance in thickness to pass under supported 10-foot straightedge.
3. Slab Type S-A: Steel gauge block 5/16 inch thick.
4. Slab Type S-B: Steel gauge block 1/8 inch thick.
5. Slab Type S-A and S-B: Finish Slab Elevation: Slope slabs to floor drain and gutter, and shall adequately drain regardless of tolerances.
6. Thickness: Maximum 1/4 inch minus or 1/2 inch plus from thickness shown. Where thickness tolerance will not affect slope, drainage, or slab elevation, thickness tolerance may exceed 1/2 inch plus.

B. Slab Elevation and Thickness:

1. Finish Slab Elevation: Slope slabs to floor drains and gutter. Slabs shall adequately drain regardless of tolerances.
2. Thickness: Maximum 1/4 inch minus or 1/2 inch plus from thickness shown. Where thickness tolerance will not affect slope, drainage, or slab elevation, thickness tolerance may exceed 1/2 inch plus.

3.07 BACKFILL AGAINST STRUCTURES

- A. Do not backfill against walls until concrete has obtained specified 28-day compressive strength.
- B. Refer to General Structural Notes on the Drawings for additional requirements, including elevated slab and diaphragm completion prior to backfill.
- C. Unless otherwise permitted, place backfill simultaneously on both sides of structure, where such fill is required, to prevent differential pressures.

3.08 FIELD QUALITY CONTROL

A. General:

1. Provide adequate facilities for safe storage and proper curing of concrete test specimens onsite for first 24 hours, and for additional time as may be required before transporting to test lab.
2. Unless otherwise specified, sample concrete for testing for making test specimens, from point of delivery.
3. When concrete is pumped, sample and test air content at point of delivery and at point of placement.
 - a. For Each Concrete Mixture: Provided results of air content tests for first load of the day are within specified limits, testing need only be performed at point of delivery for subsequent loads of that concrete mixture except that testing should be performed at point of placement every 4 hours.
4. Evaluation will be in accordance with ACI 301 and Specifications.
5. Test specimens shall be made, cured, and tested in accordance with ASTM C31/C31M and ASTM C39/C39M.
6. Frequency of testing may be changed at discretion of Engineer.
7. Pumped Concrete: Take concrete samples for slump, ASTM C143/C143M, and test specimens, ASTM C31/C31M and ASTM C39/C39M, at placement (discharge) end of line.

8. If measured air content at delivery is greater than specified limit, check test of air content will be performed immediately on a new sample from delivery unit. If check test fails, concrete has failed to meet requirements of Contract Documents. If measured air content is less than lower specified limit, adjustments will be permitted in accordance with ASTM C94/C94M, unless otherwise specified. If check test of adjusted mixture fails, concrete has failed to meet requirements of Contract Documents. Concrete that has failed to meet requirements of Contract Documents shall be rejected.

B. Concrete Strength Test:

1. Unless otherwise specified, one specimen at age of 7 days for information, and two 6-inch diameter or when permitted three 4-inch diameter test specimens at age of 28 days for acceptance.
2. If result of 7-day concrete strength test is less than 50 percent of specified 28-day strength, extend period of moist curing specified in Section 03 39 00, Concrete Curing, by 7 additional days.
3. Provide a minimum of one spare test specimen per sample. Test spare cylinder as directed by Engineer.

C. High-Range, Water-Reducer (Superplasticizer) Admixture Segregation Test: Test each truck prior to use on Project.

1. Segregation Test Objective: Concrete with 4-inch to 8-inch slump shall stay together when slumped. Segregation is assumed to cause mortar to flow out of mix even though aggregate may stay piled enough to meet slump test.
2. Test Procedure: Make slump test and check for excessive slump and observe to see if mortar or moisture flows from slumped concrete.
3. Reject concrete if mortar or moisture separates and flows out of mix.

D. Cold Weather Placement Tests:

1. During cold weather concreting, cast cylinders for field curing as follows. Use method that will produce greater number of specimens:
 - a. Six extra test cylinders from last 100 cubic yards of concrete.
 - b. Minimum three specimens for each 2 hours of placing time or for each 100 cubic yards.
2. These specimens shall be in addition to those cast for lab testing.
3. Protect test cylinders from weather until they can be placed under same protection provided for concrete of structure that they represent.
4. Keep field test cylinders in same protective environment as parts of structure they represent to determine if specified strength has been obtained.

5. Test cylinders in accordance with applicable sections of ASTM C31/C31M and ASTM C39/C39M.
6. Use test results to determine specified strength gain prior to falsework removal or for prestressing.

E. Tolerances:

1. Walls: Measure and inspect walls for compliance with tolerances specified in Section 03 10 00, Concrete Forming and Accessories.
2. Slab Finish Tolerances and Slope Tolerances:
 - a. Make floor flatness measurements day after floor is finished and before shoring is removed to eliminate effects of shrinkage, curing, and deflection.
 - b. Support 10-foot long straightedge at each end with steel gauge blocks of thicknesses equal to specified tolerance.
 - c. Compliance with designated limits in four of five consecutive measurements is satisfactory, unless defective conditions are observed.

F. Liquid Tightness Tests:

1. Purpose: To determine integrity and liquid-tightness of finished exterior and interior concrete surfaces of liquid containment structures.
2. Test the following structures for liquid-tightness:

Structure	Liquid testing EL
20 – Chlorine Dioxide Generation System	6" below top of wall

3. Potable water for initial tightness test will be provided by Owner.
 - a. Potable water currently exists at the project site. Owner will provide a place of temporary connection for construction water at Site. Provide temporary facilities and piping required to bring water to point of use and remove when no longer needed. Install an acceptable metering device and pay for water used at Owner's current rate.
4. If additional tightness tests are required because of failure to meet criteria, provide water for subsequent tests.
5. After testing has been completed, dispose of test water in a manner approved by Owner.
6. Liquid-Tightness Test Requirement:
 - a. Perform tightness tests in accordance with ACI 350.1 and as specified herein.

- b. Do not place backfill or install brick facing, grout topping slab, coatings, or other work that will cover concrete surfaces until tightness testing has been completed and approved.
 - c. Measure evaporation, precipitation, and temperature as specified.
- 7. Measure water surface at two points 180 degrees apart when possible where attachments, such as ladders exist, at 24-hour intervals.
- 8. Acceptance Criteria:
 - a. Volume loss shall not exceed 0.050 percent of contained liquid volume per 24-hour period, adjusted for evaporation, precipitation, and temperature.
 - b. Acceptance that structure has passed tightness test shall be based on total volume loss at end of specified test period.
- 9. Repairs When Test Fails:
 - a. Dewater structure;
 - 1) Inject leaking structural cracks with crack repair epoxy as specified in Section 03 64 23, Crack Repair Epoxy Injection Grouting.
 - 2) Inject leaking non-structural cracks with crack repair material as specified in Section 03 64 24, Polyurethane Injection Grouting.
 - b. Patch areas of damp spots previously recorded, and repeat water leakage test in its entirety until structure successfully passes test.

3.09 MANUFACTURER'S SERVICES

- A. Provide representative at Site in accordance with Section 01 43 33, Manufacturers' Field Services, for installation assistance, inspection, and certification of proper installation for concrete ingredients, mix design, mixing, and placement.
 - 1. Concrete Producer Representative:
 - a. Assist with concrete mix design, performance, placement, weather problems, and problems as may occur with concrete mix throughout Project, including instructions for redosing.
 - b. Establish control limits on concrete mix designs.
 - c. Provide equipment for control of concrete redosing for air entrainment or high-range, water-reducing admixture, superplasticizers, at Site to maintain proper slump and air content if needed.
 - 2. Admixture Manufacturer's Representative: Available for consultations as required to ensure proper installation and performance of specified products.
 - 3. Bonding Agent Manufacturer's Representative: Available for consultations as required to ensure proper installation and performance of specified products.

3.10 PROTECTION OF INSTALLED WORK

- A. After curing as specified in Section 03 39 00, Concrete Curing, and after applying final floor finish, cover slabs with plywood or particle board or plastic sheeting or other material to keep floor clean and protect it from material and damage as a result of other construction work.
- B. Repair areas damaged by construction, using specified repair materials and approved repair methods.

3.11 SCHEDULE OF CONCRETE FINISHES

- A. Form Tolerances: As specified in Section 03 10 00, Concrete Forming and Accessories.
- B. Special Floor Finishes: As specified in Section 03 35 00, Concrete Finishing.
- C. Provide concrete finishes as scheduled:

Area	Type of Finish	Required Form Tolerances
Exterior Wall Surfaces		
Abovegrade/exposed (above point 6" below finish grade)	W-2	W-B
Backfilled/waterproofed (below point 6" below finish grade)	W-1	W-A
Backfilled/not waterproofed (below point 6" below final grade)	W-1	W-A
Walls to receive cementitious coatings	W-4	W-B
Interior Wall Surfaces		
Water-holding tanks, channels, and basins/painted or coated	W-5	W-A
Exterior Slabs		
Water-holding tanks and basins/top of wall	S-5	S-B
Top of footing	S-2	S-A
Sidewalks	S-6	S-B
Other exterior slabs	S-5	S-A

3.12 SUPPLEMENTS

A. Requirements of concrete mix designs following “End of Section,” are a part of this Specification and supplement requirements of Part 1 through Part 3 of this section:

1. Concrete Mix Design, Class 4500F3S1P2C2.
2. Concrete Mix Design, Class 4500F3S1P1C2.

END OF SECTION

CONCRETE MIX DESIGN, CLASS 4500F3S1P2C2

- A. Mix Locations: Typical, unless otherwise specified.
- B. Exposure Categories and Classifications: F3S1P2C2.
- C. Mix Properties:
1. Limit water to cementitious materials ratio (W/Cm) in mix design to maximum value of 0.40.
 2. Minimum concrete compressive strength (f'_c) shall be 4,500 psi at 28 days.
 3. Air-entraining admixtures are prohibited in concrete mixtures and total air content shall not be greater than 3 percent, for the following:
 - a. Slabs to receive hard-troweled finish.
 4. Unless otherwise specified, provide air content based on nominal maximum size of aggregate as follows:

Nominal Maximum Aggregate Size in.‡	Air Content (%)*
3/8	7.5
1/2	7.0
3/4	6.0
1	6.0
1-1/2	5.5
2§	5.0
3§	4.5

‡See ASTM C33/C33M for tolerance on oversize for various nominal maximum size designations.

*Tolerance of air content is +1-1/2 percent.

§Air contents apply to total mixture. When testing concretes, however, aggregate particles larger than 1-1/2 inches are to be removed by sieving and air content will be measured on sieved fraction (tolerance on air content as delivered applies to this value). Air content of total mixture is computed from value measured on the sieved fraction passing the 1-1/2-inch sieve in accordance with ASTM C231/C231M.

5. Limit supplementary cementitious materials measured as a percent of weight of total cementitious materials in mix design, as follows:
 - a. Fly Ash and other Pozzolans: 25 percent.
 - b. Slag Cement: 50 percent.
 - c. Combined Fly Ash and other Pozzolans and Slag Cement: 50 percent, with fly ash and other pozzolans not exceeding 25 percent.
 - d. Total cementitious materials include ASTM C150/C150M and ASTM C595/C595M cement.
 - 1) Fly ash and other pozzolans in Type IP, blended cement, ASTM C595/C595M.
 - 2) Slag used in the manufacture of an IS blended cement, ASTM C595/C595M.
6. Provide cementitious materials in accordance with one of the following:
 - a. ASTM C150/C150M Type II; inclusion of supplementary cementitious materials in design mix is optional.
 - b. ASTM C150/C150M types other than Type II, plus supplementary cementitious materials in accordance with one of the following:
 - 1) Tricalcium Aluminate Content of Total Cementitious Materials: Maximum 8 percent by weight.
 - 2) Provide documentation of test results in accordance with ASTM C1012/C1012M, for combinations of cementitious materials providing sulfate resistance with expansion less than 0.10 percent at 6 months.
 - c. ASTM C595/C595M Type IP or Type IS (less than 70), tested to comply with moderate sulfate resistance option (MS).
 - 1) Provide documentation of test results in accordance with ASTM C1012/C1012M, for combinations of cementitious materials providing sulfate resistance with expansion less than 0.10 percent at 6 months.
7. Unless otherwise permitted, minimum cementitious materials content in mix design shall be as follows:
 - a. 515 pounds per cubic yard for concrete with 1-1/2-inch nominal maximum size aggregate.
 - b. 535 pounds per cubic yard for 1-inch nominal maximum size aggregate.
 - c. 560 pounds per cubic yard for 3/4-inch nominal maximum size aggregate.
 - d. 580 pounds per cubic yard for 1/2-inch nominal maximum size aggregate.
 - e. 600 pounds per cubic yard for 3/8-inch nominal maximum size aggregate.

- f. Unless otherwise permitted, limit cementitious materials content to 100 pounds per cubic yard greater than specified minimum cementitious materials content in mix design.
 - 8. Limit water-soluble, chloride-ion content in hardened concrete to 0.10 percent, unless otherwise specified.
 - a. Limits are stated in terms of chloride ions in percent by weight of cement.
 - b. Unless otherwise permitted, provide documentation from concrete tested in accordance with ASTM C1218/C1218M at an age between 28 days and 42 days.
- D. Refer to PART 1 through PART 3 of this section for additional requirements.

CONCRETE MIX DESIGN, CLASS 4500F3S1P1C2

- A. Mix Locations: Concrete curbs and sidewalks.
- B. Exposure Categories and Classifications: F3S1P1C2.
- C. Mix Properties:
 - 1. Limit water to cementitious materials ratio (W/Cm) in mix design to maximum value of 0.42.
 - 2. Minimum concrete compressive strength (f'_c) shall be 4,500 psi at 28 days.
 - 3. Air-entraining admixtures are prohibited in concrete mixtures and total air content shall not be greater than 3 percent, for the following:
 - a. Slabs to receive hard-troweled finish.
 - 4. Unless otherwise specified, provide air content based on nominal maximum size of aggregate as follows:

Nominal Maximum Aggregate Size in. ‡	Air Content (%)*
3/8	7.5
1/2	7.0
3/4	6.0
1	6.0
1-1/2	5.5
2§	5.0
3§	4.5

‡See ASTM C33/C33M for tolerance on oversize for various nominal maximum size designations.

*Tolerance of air content is +1-1/2 percent.

§Air contents apply to total mixture. When testing concretes, however, aggregate particles larger than 1-1/2 inches are to be removed by sieving and air content will be measured on the sieved fraction (tolerance on air content as delivered applies to this value). Air content of total mixture is computed from value measured on the sieved fraction passing the 1-1/2-inch sieve in accordance with ASTM C231/C231M.

5. Limit supplementary cementitious materials measured as a percent of weight of total cementitious materials in a mix design, as follows:
 - a. Fly Ash and other Pozzolans: 25 percent.
 - b. Slag Cement: 50 percent.
 - c. Combined Fly Ash and other Pozzolans and Slag Cement: 50 percent, with fly ash and other pozzolans not exceeding 25 percent.
 - d. Total cementitious materials include ASTM C150/C150M and ASTM C595/C595M cement.
 - 1) Fly ash and other pozzolans in Type IP, blended cement, ASTM C595/C595M.
 - 2) Slag used in the manufacture of an IS blended cement, ASTM C595/C595M.
6. Provide cementitious materials in accordance with one of the following:
 - a. ASTM C150/C150M Type II.
 - b. ASTM C150/C150M types other than Type II, plus supplementary cementitious materials in accordance with one of the following:
 - 1) Tricalcium Aluminate Content of Total Cementitious Materials: Maximum 8 percent by weight.
 - 2) Provide documentation of test results in accordance with ASTM C1012/C1012M, for combinations of cementitious materials providing sulfate resistance with expansion less than 0.10 percent at 6 months.
 - c. ASTM C595/C595M Type IP or Type IS (less than 70), tested to comply with moderate sulfate resistance option (MS).
 - 1) Provide documentation of test results in accordance with ASTM C1012/C1012M, for combinations of cementitious materials providing sulfate resistance with expansion less than 0.10 percent at 6 months.
7. Limit water-soluble, chloride-ion content in hardened concrete to 0.15 percent, unless otherwise specified.
 - a. Limits are stated in terms of chloride ions in percent by weight of cement.
 - b. Unless otherwise permitted, provide documentation from concrete tested in accordance with ASTM C1218/C1218M at an age between 28 days and 42 days.

D. Refer to PART 1 through PART 3 of this section for additional requirements.

**SECTION 03 39 00
CONCRETE CURING**

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American Concrete Institute (ACI): 308.1, Specification for Curing Concrete.
2. ASTM International (ASTM):
 - a. C309, Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete.
 - b. C1315, Standard Specification for Liquid Membrane-Forming Compounds Having Special Properties for Curing and Sealing Concrete.

1.02 SUBMITTALS

A. Action Submittals:

1. Manufacturers' data indicating compliance with the requirements specified herein for the following products:
 - a. Exposed aggregate finish retardant on formed surface.
 - b. Evaporation retardant.
 - c. Curing compound.
 - d. Penetrating water repellent sealer.
 - e. Clear liquid densifier.
2. Curing methods proposed for each type of element such as slab, walls, beams, and columns in each facility.

B. Informational Submittals:

1. Manufacturer's Certificate of Compliance, in accordance with Section 01 61 00, Common Product Requirements, for the following:
 - a. Curing compound showing moisture retention requirements.
 - b. Retardants for exposed aggregate finish.

PART 2 PRODUCTS

2.01 MATERIALS

A. Curing Compound:

1. Water-based, high-solids content, nonyellowing, curing compound meeting requirements of ASTM C1315C: Type I, Class A.
2. Manufacturers and Products:
 - a. Euclid Chemical Co., Cleveland, OH; Super Diamond Clear VOX.
 - b. WR Meadows, Inc., Hampshire, IL; VOCOMP-30.
 - c. Vexcon Chemical, Inc.; Philadelphia, PA; Starseal 1315.
 - d. Dayton Superior; Safe Cure and Seal 1315 EF.

B. Evaporation Retardant:

1. Optional: Fluorescent fugitive dye color tint that disappears completely upon drying.
2. Manufacturers and Products:
 - a. BASF Construction Chemicals, Shakopee, MN; MasterKure ER 50.
 - b. Euclid Chemical Co., Cleveland, OH; Eucobar.

C. Penetrating Water Repellent Sealer: Water based, ready to use, single component, silane/siloxane, penetrating, clear water repellent sealer.

1. Viscosity: 50 cps.
2. Flash Point: 200 degrees F.
3. NCHRP No. 244 Reduction in Chloride Content:
 - a. Average: 82 percent.
 - b. Minimum Required: 75 percent.
4. NCHRP No. 244 Reduction in Weight Gain:
 - a. 21 Days: 85 percent.
 - b. VOCs: 50 g/l.
 - c. Depth of Penetration: 1/4 inch.
5. Manufacturers and Products:
 - a. BASF Construction Chemicals, Shakopee MN; MasterProtect H 400.
 - b. Euclid Chemical Co.; Baracade WB 244.

D. Water: Clean and potable, containing less than 500 ppm of chlorides.

PART 3 EXECUTION**3.01 CONCRETE CURING****A. General:**

1. Cure all concrete in accordance with project specifications and ACI308.1.
2. Where surfaces are to receive coatings, painting, cementitious material, or other similar finishes, use only water curing procedures. Refer to Interior Finish Schedule for surfaces to receive coatings.
3. Use only water curing on potable water structures.
4. Where curing compound cannot be used, water curing as described below or special methods using moisture shall be agreed upon by Engineer prior to placing concrete.
5. As required in Section 03 30 00, Cast-in-Place Concrete, if result of 7-day concrete strength test is less than 50 percent of specified 28-day strength, extend period of moist curing specified below, by 7 additional days.

B. Use one of the following methods as approved by Engineer:

1. Vertical Surfaces
 - a. Method 1: Leave concrete forms in place and keep surfaces of forms and concrete wet for 7 days.
 - b. Method 2: Continuously sprinkle with water 100 percent of exposed surfaces for 7 days starting immediately after removal of forms.
 - c. Method 3: Apply curing compound, where allowed, immediately after removal of forms.
2. Horizontal Surfaces:
 - a. Method 1: Protect surface by water ponding for 7 days.
 - b. Method 2: Cover with burlap or cotton mats and keep continuously wet for 7 days.
 - c. Method 3: Cover with 1-inch layer of wet sand, earth, or sawdust, and keep continuously wet for 7 days.
 - d. Method 4: Continuously sprinkle exposed surface for 7 days.
 - e. Method 5: Apply curing compound, where allowed, immediately after final finishing when surface will no longer be damaged by traffic.

3.02 EVAPORATION RETARDANT APPLICATION

- A. Use on flatwork when environmental conditions are anticipated to cause rapid drying of the concrete surface.
- B. Spray onto surface of fresh flatwork concrete immediately after screeding to react with surface moisture.
- C. Reapply as needed to ensure a continuous moist surface until final finishing is completed.

3.03 MANUFACTURER'S SERVICES

- A. Provide manufacturer's representative at Site for installation assistance, inspection, and certification of proper installation for products specified.
- B. Provide curing compound manufacturer's representative to demonstrate proper application of curing compound to show coverage in one coat.

END OF SECTION

SECTION 03 62 00
GROUTING

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. ASTM International (ASTM):
 - a. C230, Standard Specification for Flow Table for Use in Tests of Hydraulic Cement.
 - b. C307, Standard Test Method for Tensile Strength of Chemical-Resistant Mortar, Grouts, and Monolithic Surfacing.
 - c. C531, Standard Test Method for Linear Shrinkage and Coefficient of Thermal Expansion of Chemical-Resistant Mortars, Grouts, Monolithic Surfacing, and Polymer Concretes.
 - d. C579, Standard Test Methods for Compressive Grout Strength of Chemical-Resistant Mortars, Grouts, Monolithic Surfacing, and Polymer Concretes.
 - e. C882, Standard Test Method for Bond Strength of Epoxy-Resin Systems Used With Concrete By Slant Shear.
 - f. C939, Standard Test Method for Flow of Grout for Preplaced-Aggregate Concrete (Flow Cone Method).
 - g. C940, Standard Test Method for Expansion and Bleeding of Freshly Mixed Grouts for Preplaced-Aggregate Concrete in the Laboratory.
 - h. C1107/C1107M, Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink).
 - i. C1181, Standard Test Methods for Compressive Creep of Chemical-Resistant Polymer Machinery Grouts.
 - j. D4263, Standard Test Method for Indicating Moisture in Concrete by the Plastic Sheet Method.

1.02 SUBMITTALS

A. Action Submittals:

1. Product data of grouts.
2. Proposed method for keeping existing concrete surfaces wet prior to placing nonshrink grout.
3. Forming method for fluid grout placements.
4. Curing method for grout.

B. Informational Submittals:

1. Manufacturer's Written Instructions:
 - a. Adding fiber reinforcing to batching.
 - b. Mixing of grout.
2. Manufacturer's proposed training schedule for grout work.
3. Manufacturer's Certificate of Compliance in accordance with Section 01 61 00, Common Product Requirements.
 - a. Grout free from chlorides and other corrosion-causing chemicals.
 - b. Nonshrink grout properties of Category II and Category III, verifying expansion at 3 days or 14 days will not exceed the 28-day expansion and nonshrink properties are not based on gas or gypsum expansion.
4. Manufacturer's Certificate of Proper Installation.
5. Statements of Qualification: Grout manufacturer's representative.
6. Test Reports:
 - a. Test report for 24-hour evaluation of nonshrink grout.
 - b. Test results and service report from demonstration and training session.
 - c. Field test reports and laboratory test results for field-drawn Samples.
7. List of Contractor's equipment installation staff trained by grout manufacturer's representative in:
 - a. Nonshrink grout installation and curing.
 - b. Epoxy grout installation and curing.

1.03 QUALIFICATIONS

- A. Grout Manufacturer's Representative: Authorized and trained representative of grout manufacturer. Minimum of 1-year experience that has resulted in successful installation of grouts similar to those for this Project.
- B. For grout suppliers not listed herein, provide completed 24-hour Evaluation of Nonshrink Grout Test Form, attached at the end of this section. Provide independent testing laboratory test results for testing conducted within last 18 months.

PART 2 PRODUCTS**2.01 NONSHRINK GROUT AND EPOXY GROUT SCHEDULE**

- A. Furnish nonshrink grout (Category I, II, and III) and epoxy grout for applications as indicated in the following schedule:

Application	Temperature Range	Max. Placing Time	
	40 deg F to 100 deg F	20 Min.	Greater Than 20 Min.
Blockouts for gate guides	I or II		II
Precast joints	I or II		II
Column baseplates single-story	I or II		II
Machine bases 25 hp or less	II	II	II
Bases for precast wall sections	II	II	II
Baseplates for columns over one story	II	II	II
Precast base joints higher than one story	II	II	II
Form Tie-Through bolt openings	II	II	II
Machine bases 26 hp and up	III or Epoxy Grout	III or Epoxy Grout	III or Epoxy Grout
Baseplates and/or soleplates with vibration, thermal movement, etc.	III or Epoxy Grout	III or Epoxy Grout	III or Epoxy Grout

2.02 NONSHRINK GROUT

- A. Category I:
1. Nonmetallic and nongas-liberating.
 2. Prepackaged natural aggregate grout requiring only the addition of water.

3. Test in accordance with ASTM C1107/C1107M:
 - a. Grout shall have flowable consistency.
 - b. Flowable for 15 minutes.
4. Grout shall not bleed at maximum allowed water.
5. Minimum strength of flowable grout, 3,000 psi at 3 days, 5,000 psi at 7 days, and 7,000 psi at 28 days.
6. Manufacturers and Products:
 - a. BASF Building System, Inc., Shakopee, MN; MasterFlow 100.
 - b. Euclid Chemical Co., Cleveland, OH; NS Grout.
 - c. Dayton Superior Corp., Miamisburg, OH; 1107 Advantage Grout.
 - d. US MIX Co., Denver, CO; US SPEC GP Grout.
 - e. Five Star Products Inc., Fairfield, CT; Five Star Grout.

B. Category II:

1. Nonmetallic, nongas-liberating.
2. Prepackaged natural aggregate grout requiring only the addition of water.
3. Aggregate shall show no segregation or settlement at fluid consistency at specified times or temperatures.
4. Test in accordance with ASTM C1107/C1107M:
 - a. Fluid consistency 20 seconds to 30 seconds in accordance with ASTM C939.
 - b. Temperatures of 40 degrees F, 80 degrees F, and 90 degrees F.
5. 1 hour after mixing, pass fluid grout through flow cone with continuous flow.
6. Minimum strength of fluid grout, 3,500 psi at 1 day, 4,500 psi at 3 days, and 7,500 psi at 28 days.
7. Maintain fluid consistency when mixed in 1-yard to 9-yard loads in ready-mix truck.
8. Manufacturers and Products:
 - a. BASF Building Systems, Inc., Shakopee, MN; MasterFlow 928.
 - b. Five Star Products Inc., Fairfield, CT; Five Star Fluid Grout 100.
 - c. Euclid Chemical Co., Cleveland, OH; Hi Flow Grout.
 - d. Dayton Superior Corp., Miamisburg, OH; Sure Grip High Performance Grout.
 - e. US MIX Co., Denver, CO; US SPEC MP Grout.

C. Category III:

1. Metallic and nongas-liberating.
2. Prepackaged aggregate grout requiring only the addition of water.
3. Aggregate shall show no segregation or settlement at fluid consistency at specified times or temperatures.

4. Test in accordance with ASTM C1107/C1107M:
 - a. Fluid consistency 20 seconds to 30 seconds in accordance with ASTM C939.
 - b. Temperatures of 40 degrees F and 100 degrees F.
5. 1 hour after mixing, pass fluid grout through flow cone with continuous flow.
6. Minimum strength of fluid grout, 4,000 psi at 1 day, 5,000 psi at 3 days, and 9,000 psi at 28 days.
7. Maintain fluid consistency when mixed in 1-yard to 9-yard loads in ready-mix truck.
8. Manufacturer and Product:
 - a. BASF Building Systems, Inc., Shakopee, MN; MasterFlow 885.
 - b. Euclid Chemical Co, Cleveland, OH; Hi-Flow Metallic Grout.

2.03 EPOXY GROUT

- A. High-strength, nonshrink, high-temperature epoxy grouting material developed for the support of heavy equipment with vibratory loads.
- B. Three-component mixture of a two-component epoxy resin system (100 percent solids) with a graded, precision aggregate blend.
- C. Premeasured, prepackaged system.
- D. Flowable.
- E. Minimum compressive strength in accordance with ASTM C579 Method B, 9,500 psi at 75 degrees F at 7 days, 11,000 psi at post cure.
- F. Maximum creep resistance in accordance with ASTM C1181 at 600 psi, 140 degrees F; 6.0×10^{-3} in/in.
- G. Minimum bond strength in accordance with ASTM C882, 2,000 psi.
- H. Minimum tensile strength in accordance with ASTM C307, 2,000 psi.
- I. Maximum coefficient of thermal expansion in accordance with ASTM C531 at 73 degrees F to 210 degrees F, 23.0×10^{-6} in/in/degrees F.
- J. Working Time: Minimum 2 hours at 50 degrees F; 1.5 hours at 70 degrees F; 50 minutes at 90 degrees F.
- K. Good chemical resistance.
- L. Good effective bearing area.
- M. Noncorrosive.

- N. Moisture insensitive.
- O. Modify resin and aggregate content where recommended by epoxy grout manufacturer to provide desired epoxy grout flow properties.
- P. Manufacturer and Product:
 - 1. BASF Building System, Inc., Shakopee MN; MasterFlow 648.
 - 2. Euclid Chemical Co., Cleveland, OH; E³-G.
 - 3. Dayton Superior Corp., Miamisburg, OH; Pro-Poxy 2000 Normal Set.
 - 4. Five Star Products Inc., Fairfield, CT; DP Epoxy Grout.

PART 3 EXECUTION

3.01 GROUT

- A. General: Mix, place, and cure grout in accordance with grout manufacturer's representative's training instructions.
- B. Epoxy Grout: Concrete slab shall be fully cured for 28 days to ensure excess water has evaporated. Test concrete surface for moisture in accordance with ASTM D4263 before epoxy grout is placed.
- C. Form Tie-Through Bolt Holes: Provide nonshrink grout, Category II, fill space with dry pack dense grout hammered in with steel tool and hammer. Through-bolt holes; coordinate dry pack dense grout application with vinyl plug in Section 03 10 00, Concrete Forming and Accessories, and bonding agent in Section 03 30 00, Cast-in-Place Concrete.
- D. Form Snap-Tie Hole: Fill tie hole in accordance with requirements of Section 03 30 00, Cast-in-Place Concrete.

3.02 GROUTING MACHINERY FOUNDATIONS

- A. Block out original concrete or finish off at distance shown below bottom of machinery base with grout. Prepare concrete surface by sandblasting, chipping, or by mechanical means to remove any soft material. Surface roughness in accordance with manufacturer's written instructions.
- B. Clean metal surfaces of all paint, oil, grease, loose rust, and other foreign material that will be in contact with grout.
- C. Sandblast to bright metal all metal surfaces in contact with epoxy grout in accordance with manufacturer's written instructions.
- D. Set machinery in position and wedge to elevation with steel wedges, or use cast-in leveling bolts. Remove wedges after grout is set and pack void with grout.

- E. Form with watertight forms at least 2 inches higher than bottom of plate.
- F. Fill space between bottom of machinery base and original concrete in accordance with manufacturer's representative's training instructions.
- G. If grout cannot be placed from one edge and flowed to the opposite edge, air vents shall be provided through the plate to prevent air entrapment.
- H. Radius all corners of grout pad.
- I. Install expansion joints for epoxy grout placement in accordance with manufacturer's written instructions.

3.03 TANK FOUNDATIONS

- A. Prepare concrete surface by sandblasting, chipping, or by mechanical means to remove any soft material. Surface roughness in accordance with manufacturer's written instructions.
- B. Clean metal surfaces of all paint, oil, grease, loose rust and other foreign material that will be in contact with grout.
- C. Set tank in position and wedge to elevation with steel wedges, or use cast-in leveling bolts. Remove wedges after grout is set and pack void with grout.
- D. Form with watertight forms at least 2 inches higher than bottom of plate.
- E. Fill space between bottom of tank base and original concrete in accordance with manufacturer's representative's training instructions.

3.04 FIELD QUALITY CONTROL

- A. General:
 - 1. Performed by Project representative's inspection staff.
 - 2. Perform the following quality control inspections. The grout manufacturer's representative shall accompany the Project representative's inspection staff on the first installation of each size and type of equipment.
- B. Evaluation and Acceptance of Nonshrink Grout:
 - 1. Inspect the surface preparation of concrete substrates onto which nonshrink grout materials are to be applied, for conformance to the specified application criteria including, but not limited to, substrate profile, degree of cleanliness, and moisture.
 - 2. Inspect preparation and application of nonshrink grout form work for conformance to the manufacturer's recommendations.

3. Conduct a final review of completed nonshrink grout installation for conformance to these Specifications.
4. Provide a flow cone and cube molds with restraining plates onsite. Continue tests during Project as demonstrated by grout manufacturer's representative.
5. Perform flow cone and bleed tests, and make three 2-inch by 2-inch cubes for each 25 cubic feet of each type of nonshrink grout used. Use restraining caps for cube molds in accordance with ASTM C1107/C1107M.
6. For large grout applications, make three additional cubes and one more flow cone test. Include bleed test for each additional 25 cubic feet of nonshrink grout placed.
7. Consistency: As specified in Article Nonshrink Grout. Flow cone test in accordance with ASTM C939. Grout with consistencies outside range requirements shall be rejected.
8. Segregation: As specified in Article Nonshrink Grout. Grout when aggregate separates shall be rejected.
9. Nonshrink grout cubes shall test equal to or greater than minimum strength specified.
10. Strength Test Failures: Nonshrink grout work failing strength tests shall be removed and replaced.
11. Perform bleeding test in accordance with ASTM C940 to demonstrate grout will not bleed.
12. Store cubes at 70 degrees F.
13. Independent testing laboratory shall prepare, store, cure, and test cubes in accordance with ASTM C1107/C1107M.
14. All grout, already placed, which fails to meet the requirements of these Specifications, is subject to removal and replacement at no additional cost to the Owner.

C. Evaluation and Acceptance of Epoxy Grout:

1. Inspect ambient conditions during various phases of epoxy grouting installation for conformance with the epoxy grout manufacturer's requirements.
2. Inspect the surface preparation of concrete substrates onto which epoxy grout materials are to be applied, for conformance to the specified application criteria including, but not limited to, substrate profile, degree of cleanliness, and moisture.
3. Inspect the surface preparation of the metallic substrates onto which the epoxy primer is to be applied.
4. Inspect the epoxy-primed metallic substrate for coverage and adhesion.
5. Inspect preparation and application of epoxy grout form work for conformance to the manufacturer's recommendation.
6. Verify consistency obtained is sufficient for the proper field placement at the installed temperatures.

7. Inspect and record that the “pot life” of epoxy grout materials is not exceeded during the installation.
8. Inspect epoxy grout for cure.
9. Inspect and record that localized repairs made to grout voids are in conformance with the specification requirements.
10. Conduct a final review of completed epoxy grout installation for conformance to these Specifications.
11. Compression tests and fabrication of specimens for epoxy grout shall be made in accordance to ASTM C579, Method B, at intervals during construction as selected by the Project representative. A set of three specimens shall be made for testing at 7 days, and each earlier time period as appropriate.
12. Independent testing laboratory shall prepare, store, cure, and test cubes in accordance with ASTM C579.
13. All grout, already placed, which fails to meet the requirements of these Specifications, is subject to removal and replacement at no additional cost to the Owner.

3.05 MANUFACTURER’S SERVICES

A. General:

1. Coordinate demonstrations, training sessions, and applicable Site visits with grout manufacturer’s representative. Allow 2-week notice to grout manufacturer’s representative for scheduling purposes.
2. Provide and conduct onsite, demonstration and training sessions for bleed tests, mixing, flow cone measurement, cube testing, application, and curing for each category and type of grout.
3. Necessary equipment and materials shall be available for demonstration.
4. Conduct training prior to equipment mount installation work on equipment pads.
5. Training for each type of grout shall be not less than 4 hours’ duration.

B. Nonshrink Grout Training:

1. Training is required for all Type II and Type III grout installations.
2. Provide nonshrink grout installation training by the qualified grout manufacturer’s representative for Contractor’s workers that will be installing nonshrink grout for baseplates and equipment mounts. Schedule training to allow Engineer’s attendance.
3. Mix nonshrink grouts to required consistency, test, place, and cure on actual Project, such as, baseplates and form tie-through bolt holes to provide actual on-the-job training.

4. Use minimum of two bags for each grout Category II and Category III. Mix grout to fluid consistency and conduct flow cone and two bleed tests, make a minimum of six cubes for testing of two cubes at 1 day, 3 days, and 28 days. Use remaining grout for final Work.
5. Include recommended grout curing methods in the training.
6. Mix and demonstrate patching through-bolt holes, and similar items.
7. Transport test cubes to independent test laboratory and obtain test reports.
8. Training by manufacturer's representative does not relieve Contractor of overall responsibility for this portion of the work.
9. Submit a list of attendees that have been satisfactorily trained to perform epoxy grout installation for equipment mounting.

C. Epoxy Grout Training:

1. Provide epoxy grout installation training by the qualified epoxy grout manufacturer's representative for Contractor's workers that will be installing epoxy grout for equipment mounts. Schedule training to allow Engineer's attendance.
2. Include training in:
 - a. Performance testing such as compressive strength testing of the epoxy grout.
 - b. All aspects of using the products, from mixing to application.
3. Transport test cubes to independent test laboratory and obtain test reports.
4. Training by manufacturer's representative does not relieve Contractor of overall responsibility for this portion of the work.
5. Submit a list of attendees that have been satisfactorily trained to perform epoxy grout installation for equipment mounting.

3.06 SUPPLEMENTS

- A. The supplement listed below, following "End of Section," is part of this Specification.
1. 24-hour Evaluation of Nonshrink Grout Test Form and Grout Testing Procedures.

END OF SECTION

SUPPLEMENT 1

(Test Lab Name)

(Address)

(Phone No.)
24-HOUR EVALUATION OF NONSHRINK GROUT TEST FORM

OBJECTIVE: Define standard set of test procedures for an independent testing laboratory to perform and complete within a 24-hour period.

SCOPE: Utilize test procedures providing 24-hour results to duplicate field grouting demands. Intent of evaluation is to establish grout manufacturer's qualifications.

PRIOR TO TEST: Obtain three bags of each type of grout.

1. From intended grout supplier for Project.
2. Three bags of grout shall be of same lot number.

ANSWER THE FOLLOWING QUESTIONS FOR GROUT BEING TESTED FROM LITERATURE, DATA, AND PRINTING ON BAG:

- | | | |
|----|---|------------------|
| A. | Product data and warranty information contained in company literature and data? | Yes_____ No_____ |
| B. | Literature and bag information meet specified requirements? | Yes_____ No_____ |
| C. | Manufacturer guarantees grout as specified in Article Guarantee? | Yes_____ No_____ |
| D. | Guarantee extends beyond grout replacement value and allows participation with Contractor in replacing and repairing defective areas? | Yes_____ No_____ |
| E. | Water demands and limits printed on bag? | Yes_____ No_____ |
| F. | Mixing information printed on the bag? | Yes_____ No_____ |
| G. | Temperature restrictions printed on bag? | Yes_____ No_____ |

*Rejection of a grout will occur if one or more answers are noted NO.

GROUT TESTING PROCEDURES

A. Bagged Material:

1. List lot numbers. _____
2. List expiration date. _____
3. Weigh bags and record weight. _____

Owner's Representative will disqualify grout if bag weights have misstated measure plus or minus 2 pounds by more than one out of three bags. (Accuracy of weights is required to regulate amount of water used in mixing since this will affect properties.)

B. Mixing and Consistency Determination:

1. Mix full bag of grout in 10-gallon pail.
2. Use electric drill with a paddle device to mix grout (jiffy or jiffler type paddle).
3. Use maximum water allowed per water requirements listed in bag instructions.
4. Mix grout to maximum time listed on bag instructions.
5. In accordance with ASTM C939 (flow cone) determine time of mixed grout through the flow cone. _____ seconds
6. Add water to attain 20- to 30-second flow in accordance with ASTM C939.
7. Record time of grout through cone at new water demand. _____ seconds
8. Record total water needed to attain 20- to 30-second flow. _____ pounds
9. Record percent of water. _____ percent

C. When fluid grout is specified and additional water is required beyond grout manufacturer's listed maximum water, ASTM C1107/C1107M will be run at new water per grout ratio to determine whether grout passes using actual water requirements to be fluid. Use new water per grout ratio on remaining tests.

D. Bleed Test:

1. Fill two gallon cans half full of freshly mixed grout at ambient temperatures for each category and at required consistency for each.
2. Place one can of grout in tub of ice water and leave one can at ambient temperature.
3. Cover top of both cans with glass or plastic plate preventing evaporation.
4. Maintain 38 degrees F to 42 degrees F temperature with grout placed in ice and maintain ambient temperature for second container for 1 hour.
5. Visually check for bleeding of water at 15-minute intervals for 2 hours.
6. Perform final observation at 24 hours.

If grout bleeds a small amount at temperatures specified, grout will be rejected.

E. Extended Flow Time and Segregation Test (for Category II and Category III):

1. Divide the remaining grout into two 3-gallon cans. Place the cans into the 40-degree F and 90-degree F containers and leave for 20, 40, and 60 minutes. Every 20 minutes remove and check for segregation or settlement of aggregate. Use a gloved hand to reach to the bottom of the can, if more than 1/4 inch of aggregate has settled to the bottom or aggregate has segregated into clumps reject the grout.
2. Right after the settlement test mix the grout with the drill mixer for 10 seconds. Take a ASTM C939 flow cone test of grout and record flow time. Maintain this process for 1 hour at ambient temperatures of 40 degrees F and 90 degrees F.
 - a. 20 min _____, sec. @ 40 degrees F.
 - b. 40 min _____, sec. @ 40 degrees F.
 - c. 60 min _____, sec. @ 40 degrees F.
 - d. 20 min _____, sec. @ 90 degrees F.
 - e. 40 min _____, sec. @ 90 degrees F.
 - f. 60 min _____, sec. @ 90 degrees F.

All Category II and Category III grout that will not go through the flow cone with continuous flow after 60 minutes will be disqualified.

Qualified

Disqualified

F. 24-hour Strength Test:

1. Using grout left in mixing cans in accordance with ASTM C1107/C1107M for mixing and consistency determination test and for extended time flow test, make minimum of nine cube samples.
2. Store cubes at 70 degrees F for 24 hours.
3. Record average compressive strength of nine cubes at 24 hours.

Grout will be disqualified if 24-hour compressive strengths are less than 2,500 psi for grouts claiming fluid placement capabilities.

Grouts that have not been disqualified after these tests are qualified for use on the Project for the application indicated in Nonshrink Grout Schedule.

Signature of Independent Testing Laboratory

Date Test Conducted

SECTION 03 63 00
CONCRETE DOWELING

PART 1 GENERAL

1.01 REFERENCES

- A. The following is a list of standards that may be referenced in this section:
1. American National Standards Institute (ANSI).
 2. ASTM International (ASTM):
 - a. C881/C881M, Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete.
 - b. E488, Standard Test Methods for Strength of Anchors in Concrete and Masonry Elements.
 3. International Code Council (ICC):
 - a. 2012 International Building Code (IBC).
 - b. Evaluation Services Reports.

1.02 DEFINITIONS

- A. ICC Evaluation Services Report: Published by ICC for products provided by concrete adhesive anchor manufacturers.
- B. Special Inspection: As defined in the ICC IBC and indicated on the Statement of Special Inspection (Plan) in Supplement located at end of Section 01 45 33, Special Inspection, Observation, and Testing.

1.03 SUBMITTALS

- A. Action Submittals:
1. Product Data: Manufacturer's catalog information.
- B. Informational Submittals:
1. Manufacturer's instructions for preparation, placement, drilling of holes, installation of anchors and adhesive, and handling of cartridges, nozzles, and equipment.
 2. Manufacturer's written letter of certification identifying installer's qualifications to install products.
 3. ICC Evaluation Services Report: Specific to proposed doweling system manufacturer.

1.04 QUALITY ASSURANCE

A. Qualifications:

1. Manufacturer: At least three similar projects with same products within last 3 years.
2. Installer: Trained and certified by manufacturer.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Container Markings: Include manufacturer's name, product name, batch number, product expiration date, ANSI hazard classification, and appropriate ANSI handling precautions.
- B. Store adhesive components in accordance with manufacturer's written instructions.
- C. Dispose of when:
 1. Shelf life has expired.
 2. Stored other than per manufacturer's instructions.

PART 2 PRODUCTS

2.01 MATERIALS

A. Adhesive:

1. Approved by an ICC Evaluation Services Report for conformance to 2012 IBC requirements for doweling of steel reinforcing bars in cracked concrete.
2. Suitable for long-term loads as well as for wind and seismic loads.
3. Meet requirements of ASTM C881/C881M.
4. Two-component, insensitive to moisture, designed to be used in adverse freeze/thaw environments.
5. Disposable, Self-Contained Cartridge System:
 - a. Capable of dispensing both components in proper mixing ratio.
 - b. Fit into manually or pneumatically operated caulking gun.
6. Mixed Adhesive: Nonsag, light paste consistency with ability to remain in a 1-inch diameter overhead drilled hole without runoff.
7. Cure Temperature, Pot Life, and Workability: Compatible for intended use and anticipated environmental conditions.
8. Manufacturers and Products:
 - a. Hilti, Inc., Tulsa, OK; HIT-RE 500-SD (ESR-2322) or HIT-HY 200 (ESR-3187) Adhesive Anchors.
 - b. Powers Fasteners, Brewster, NY; Power PURE110+ Epoxy Adhesive Anchor System (ESR-3298).

- c. Simpson Strong-Tie Co., Inc., Pleasanton, CA; SET-XP Epoxy Adhesive Anchors (ESR-2508).
- B. Mixing Nozzles: Disposable, manufactured in several sizes to accommodate size of reinforcing dowels.
- C. Reinforcing Dowels: As specified in Section 03 21 00, Steel Reinforcement.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Drilling Equipment:
 - 1. Drilling Hammers for Dowel Holes:
 - a. Electric or pneumatic rotary type with medium or light impact.
 - b. Hollow drills with flushing air systems are preferred.
 - 2. Where edge distances are less than 2 inches, use lighter impact equipment to prevent microcracking and concrete spalling during drilling process.
- B. Hole Diameter: Use drill bit diameter meeting ICC Evaluation Services Report requirements and as recommended by manufacturer.
- C. Obstructions in Drill Path: When existing steel reinforcement is encountered during drilling, obtain Engineer approval for proposed fix.
- D. Doweling:
 - 1. Install per details shown on Drawings and in accordance with adhesive manufacturer's instructions.
 - 2. When using epoxy anchors, dowels may be prebent prior to installation to 15 degrees to align with other bars. Do not heat dowels to bend.
 - 3. Bent Bar Dowels: Where edge distances are critical, and intersection with steel reinforcement is likely, drill hole at 10-degree angle or less and use prebent reinforcing bars.
- E. Adhesive:
 - 1. Install in accordance with written manufacturer's instructions.
 - 2. Dispense components through specially designed static mixing nozzle that thoroughly mixes components and places mixed adhesive at base of predrilled hole.

3.02 FIELD QUALITY ASSURANCE AND QUALITY CONTROL

- A. Owner-Furnished Quality Assurance, in accordance with IBC Chapter 17 requirements, is provided in the Statement of Special Inspection (Plan) in Supplement located at end of Section 01 45 33, Special Inspection, Observation, and Testing. Contractor responsibilities and related information on special inspection and testing are included in Section 01 45 33, Special Inspection, Observation, and Testing.
1. Special inspection will be performed by the Special Inspector in accordance with ICC ESR requirements and as specified in Section 01 45 33, Special Inspection, Observation, and Testing.
 2. Continuous inspection required where noted in Supplement located at end of Section 01 45 33, Special Inspection, Observation, and Testing and where concrete dowels are installed in overhead applications.
 3. Periodic inspection required where continuous inspection is not specified.
 4. Special Inspector will observe installation in accordance with requirements of the ICC Evaluation Services Report and will submit report including the following:
 - a. Product Description: Product name, rod diameter, and length.
 - b. Drill bit compliance.
 - c. Hole diameter, diameter, and depth and cleanliness.
 - d. Adhesive expiration date.
 5. Verification of dowel installation in accordance with manufacturer's published instructions
- B. Contractor-Furnished Quality Control: Inspection and testing as required in Section 01 45 16.13, Contractor Quality Control.

END OF SECTION

SECTION 03 64 23
EPOXY RESIN INJECTION GROUTING

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. ASTM International (ASTM):
 - a. C882, Standard Specification for Test Method for Bond Strength of Epoxy Resin System Used with Concrete by Slant Shear.
 - b. D570, Standard Test Method for Water Absorption of Plastics.
 - c. D638, Standard Test Method for Tensile Properties of Plastics.
 - d. D648, Standard Test Method for Deflection Temperature of Plastics under Flexural Load in the Edgewise Position.
 - e. D695, Standard Test Method for Compressive Properties of Rigid Plastics.
 - f. D790, Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.

1.02 DEFINITIONS

- A. Crack: Complete or incomplete separation of concrete into two or more parts produced by breaking or fracturing.
- B. Defective Area: As defined in Section 03 30 00, Cast-in-Place Concrete.
- C. Hydraulic Structure: Liquid containment structure and/or structure designed to mitigate liquid infiltration.
- D. Injection: Method of bonding together, addressing or eliminating leakage through cracks or joints by installing resin under pressure to fill the void in crack or joint.
- E. Joint: A planned and formed discontinuity in concrete structure at junction of adjacent and sequential concrete placements and may contain embedded waterstops.
- F. Leak or Leakage: Crack or joint exhibiting presence of moisture, sign of efflorescence, intermittently wet to touch, or continuous flow of liquid.
- G. Narrow Cracks: Width equal to or less than 0.015 inch.
- H. Wide Cracks: Wider than 0.015 inch.

1.03 SUBMITTALS

A. Action Submittals:

1. Physical and chemical properties for epoxy resin.
2. Technical data for metering, mixing, and injection equipment.
3. Depth of penetration, length, material used, and procedures where epoxy is approved for use.
4. Marked up drawings of proposed epoxy injection repair crack locations, widths, and lengths and direction on structure.
5. Sample bottle.

B. Informational Submittals:

1. Manufacturer's recommended surface preparation procedures and application instructions for epoxy resins.
2. Manufacturer's Certificate of Compliance in accordance with Section 01 61 00, Common Product Requirements. Certified test results for each batch of epoxy resin.
3. Statements of Qualification for Epoxy Resin:
 - a. Manufacturer's Site representative.
 - b. Injection applicator.
 - c. Injection pump operating technician.
4. Sample of epoxy resin two component ratio and injection pressure test records for concrete crack repair work.
5. Installation instructions for repairing core holes with repair mortar.
6. Epoxy resin two component ratio and injection pressure test records for concrete crack repair work.

1.04 QUALITY ASSURANCE

A. Qualifications for Injection Staffs:

1. Manufacturer's Site Representative:
 - a. Capable of instructing successful methods of epoxy injection process for concrete structure.
 - b. Understands and is capable of explaining technical aspects of correct material selection and use.
 - c. Experienced in operation, maintenance, and troubleshooting of application equipment.
2. Injection Crew and Job Foreman:
 - a. Provide written and verifiable evidence showing compliance with the following requirements:
 - 1) Licensed or certified by epoxy resin material manufacturer.

- 2) Minimum 3 years' experience in successful epoxy injection for at least 10,000 linear feet of successful crack injection, including 2,000 linear feet of wet crack injection to stop water leakage.
- B. Injected Epoxy Resin: Fill cracks with minimum resin depth penetration no less than 90 percent of:
1. Full thickness of concrete section for cracks or joints.
 2. Depth between waterstop and inside face of structure for joints with an embedded waterstop.
- C. Injected cracks which leak shall be considered deficient work irrespective of depth of penetration. Reinjection of deficient work or, with approval of Engineer, provide other repairs to eliminate leakage.
- D. Bond Strength Test for Epoxy Resin:
1. Concrete failure before resin failure.
 2. 1,500 psi minimum bond strength per ASTM C882 test requirements with no failure of either concrete or epoxy resin.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Packing and Shipping:
1. Package resin material in new sealed containers and label with following information:
 - a. Manufacturer's name.
 - b. Product name and lot number.
 - c. ANSI Hazard Classification.
 - d. ANSI recommended precautions for handling.
 - e. Mix ratio by volume for components.
- B. Storage and Protection: Store epoxy resin material containers in accordance with manufacturer's printed instructions and at ambient temperatures below 110 degrees F and above 45 degrees F.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Materials and accessories specified in this section shall be products of:
1. BASF Construction Chemicals, LLC-Building Systems, Shakopee, MN; SCB Concreive Series products that meet properties indicated in sub-section 2.2.B.

2. Sika Corp., Lyndhurst, NJ; Sikadur Series products that meet properties below.
3. Euclid Chemical Co., Cleveland, OH; Euco Series (#452) products that meet properties below.

2.02 EPOXY INJECTION RESIN

A. Two-component A and B structural epoxy resin for injection into cracks in concrete structures for bonding or grouting.

B. Uncured Resin Properties:

1. When mixed in ratio specified on resin container label:

	Test Method	Wide Cracks or Joints	Narrow Cracks or Joints
Pot Life (60-gram mass) @ 77, plus or minus 4 deg F	As specified in Article Source Quality Control	13 to 25 minutes	15 to 30 minutes
Pot Life (60-gram mass) @ 100, plus or minus 4 deg F	As specified in Article Source Quality Control	3 to 10 minutes	10 to 20 minutes
Viscosity @ 40, plus or minus 3 deg F	Brookfield RVT Spindle No. 4 @ 20 rpm	4,400 cps	600 cps
Viscosity @ 75 to 77 deg F	Brookfield RVT Spindle No. 2 @ 20 rpm	375 to 350 cps	175 to 140 cps

C. Epoxy Resin Properties: When cured for 7 days at 77 degree F, plus or minus 3 degrees F and conditioned at test temperature 12 hours prior to test, unless otherwise specified.

	Test Method	Wide Cracks or Joints	Narrow Cracks or Joints
Ultimate Tensile Strength, psi	ASTM D368	8,000 min.	5,000 min.
Tensile Elongation @ Break, percent	ASTM D638	4.2 max.	3.0 max.
Flexural Strength, psi	ASTM D790	10,000 min.	10,000 min.

	Test Method	Wide Cracks or Joints	Narrow Cracks or Joints
Flexural Modulus, psi	ASTM D790	5.5×10^5 min.	4.5×10^5 min.
Compressive Yield Strength, psi	ASTM D695*	15,000 min.	12,000 min.
Compressive Modulus, psi	ASTM D695*	4.0×10^5 min.	4.0×10^5 min.
Heat Deflection Temperature	ASTM D648*	130 deg F min.	140 deg F min.
Cured 3 days @ 40 deg F – Wet Concrete		3,500 psi min.	3,500 psi min.
Cured 1 day @ 77 deg F – Dry Concrete		5,000 psi min.	5,000 psi min.
Cured 3 days @ 77 deg plus or minus 3 deg F		5,000 psi min.	5,000 psi min.
*Cure test specimens so that peak exothermic temperature of resin does not exceed 100 degrees F.			
Note: See referenced specifications for preparation method of test specimens.			

2.03 SURFACE SEAL

- A. Sufficient strength and adhesion for holding injection fittings firmly in place and to resist pressures preventing leakage during injection.
- B. Capable of removal after injection resin has cured.

2.04 WATER

- A. Clean and free from oil, acid, alkali, organic matter, or other deleterious substances, meeting federal ANSI/NSF Standard 60 drinking water standards.

2.05 SAMPLE BOTTLE

- A. Five-inch natural wide mouth HDPE bottle or 4-ounce clear PVC cylinder bottle; supplied with caps.

2.06 SOURCE QUALITY CONTROL

- A. Test Requirements: Perform tests for each batch of epoxy resin.
- B. Pot Life Test:
 - 1. Condition Component A and Component B to required temperature.

2. Measure components in ratio of Component B as stated on manufacturer's label into an 8-fluid ounce paper cup.
 3. Mix components for 60 seconds using non-metallic stirring instrument. Scrape sides and bottom of cup periodically.
 4. Probe mixture once with non-metallic stirring instrument every 30 seconds, starting 2 minutes prior to minimum specified pot life.
 5. Pot Life Definition: Time at which a soft stringy mass forms in center of cup.
- C. Slant Shear Test: Prepare specimens and perform tests in accordance with ASTM C882.

PART 3 EXECUTION

3.01 GENERAL

- A. Unless permitted otherwise, structurally repair cracks listed below:
1. Cracks considered to be defective as defined in Section 03 30 00, Cast-in-Place Concrete.
- B. Do not proceed with injection work until submittals have been reviewed and approved by Engineer.
- C. Perform cracks or joints injection work after removing defective surface materials and after performing surface preparation, but prior to applying surface repair material unless otherwise noted. See Section 03 01 32, Repair of Vertical and Overhead Concrete Surfaces, and Section 03 01 33, Repair of Horizontal Concrete Surfaces, for concrete surface repair system.
- D. Width of cracks may vary along length and through thickness of concrete section.
- E. Remove all excess, unused epoxy resin materials on concrete surfaces exposed to view prior to end of Work.

3.02 EQUIPMENT

- A. Portable, positive displacement type pumps with in-line metering to meter and mix two epoxy resin components and inject mixture into cracks or joints.
- B. Pumps:
1. Electric or air powered with interlocks providing positive ratio control of proportions for the two components at nozzle.
 2. Primary injection pumps for each material of different mix ratio, including a standby backup pump of similar ratio.

3. Capable of immediate compensation for changes in resins.
 4. Do not use batch mix pumps.
- C. Discharge Pressure: Automatic pressure controls capable of discharging mixed epoxy resin at pressures in accordance with epoxy resin manufacturer's printed instruction and able to maintain pressure.
 - D. Automatic Shutoff Control: Provide sensors on both Component A and Component B reservoirs for stopping machine automatically when only one component is being pumped to mixing head.
 - E. Proportioning Ratio Tolerance: Maintain epoxy resin manufacturer's prescribed mix ratio within a tolerance of plus or minus 5 percent by volume at discharge pressure up to 160 psi.
 - F. Ratio/Pressure Check Device:
 1. Two independent valve nozzles capable of controlling flow rate and pressure by opening or closing valve to restrict material flow.
 2. Pressure gauge capable of sensing pressure behind each valve.

3.03 PREPARATION

- A. Free cracks from loose matter, dirt, laitance, oil, grease, efflorescence, salt, and other contaminants.
- B. Clean cracks in accordance with epoxy resin manufacturer's instructions.
- C. Clean surfaces adjacent to cracks from dirt, dust, grease, oil, efflorescence, and other foreign matter detrimental to bond of surface seal system and to expose the full extent of cracks and joints in accordance with manufacturer's printed instruction.
- D. Do not use acids and corrosives for cleaning, other than those specified herein unless neutralized prior to injecting epoxy resin.
- E. During installation and curing of materials, if ambient temperature is expected to drop below manufacturer's recommended minimum temperature, provide enclosures and heat as required.
- F. Provide work platforms as required.
- G. Dry out cracks or joints if required by manufacturer's instructions.

3.04 APPLICATION

- A. All liquid is to be removed from hydraulic structure prior to commencing with epoxy injection, unless approved otherwise.

B. Entry Ports:

1. Establish openings for epoxy resin entry in surface seal along crack.
2. Determine space between entry ports equal to thickness of concrete member to allow epoxy resin to penetrate to the full thickness of the member.
3. Drill injection holes at an angle between 45 degrees and 60 degrees from surface of concrete and perpendicular to alignment of cracks, to intersect crack at midpoint of concrete section, and intersect joints at midpoint between waterstop and interior concrete surface, except as noted otherwise.
4. Locate drill holes on alternate sides of crack where possible, unless orientation of crack is known or has been verified by non-destructive testing techniques or core drilling.
5. Drill Hole Spacing: Do not to exceed concrete thicknesses or 12 inches maximum, except as noted otherwise.
6. Adjust location and angle of drill holes to suit orientation of crack and at commencement of drilling holes for injection and at beginning of each subsequent shift.
7. Take measures to prevent drilling holes for injection too shallow or too deep, or damaging existing waterstop in joints.
8. Remove dust and debris in drill holes and on surface of structure resulting from drilling operation, by flushing with water prior to installing the injection packers or ports.
9. Space entry ports closer together to allow adjustment of injection pressure to obtain minimum loss of epoxy to soil at locations where:
 - a. Cracks or joints extend entirely through concrete element.
 - b. Backfill of walls on one side.
 - c. Slab-on-grade.
 - d. Difficult to excavate behind wall to seal both surfaces of crack.
10. Install injection packers or ports in drill holes in accordance with manufacturer's printed instructions with zerk coupling or other one-way ball or check valve, to permit testing for watertightness and acid flushing of cracks.

C. Application of Surface Seal along Cracks:

1. Apply surface seal in accordance with manufacturer's instructions to designated cracks face prior to injection. Seal surface of cracks to contain and prevent escape of injection epoxy.
2. Cure surface seal in accordance with manufacturer's printed instructions before commencing inject work.

D. Epoxy Injection:

1. Ensure zerk coupling is not installed in ports or packers next to the one being injected.
2. Start injection into each crack at lowest elevation entry port or packer along vertical or diagonal crack , and at one end of horizontal crack.
3. Where injection entry ports or packers are used, continue injection at first port or packer until resin begins to flow out of port or packer at next highest elevation. Plug first port or packer and start injection at second port or packer until resin flows from next port or packer.
4. Inject entire crack with same sequence.
5. At no time inject more than 6 feet length of first vertical crack before verifying resin in sample bottle has start to set and cure.
6. Prior to commencing injection work along a horizontal crack in structure when processed using ports or packers with zerk couplings are used, remove zerk couplings from injection ports or packers except for two ports or packers located where injection work will commence. Commence injection work in first two ports or packers. Once clean resin is vented from third injection port or packer, cease injection at first port or packer, and install zerk coupling and commence injection at third port or packer. Repeat process for fourth and subsequent ports or packers until full length of crack has been injected.

E. Finishing:

1. Allow epoxy resin to cure in accordance with manufacturer's instruction after cracks have been completely injected to allow surface seal removal without draining or runback of uncured epoxy resin material from cracks.
2. Remove surface seal and injection packers from cured injection resin along crack.
3. Finish crack faces flush with adjacent concrete.
4. Indentations or protrusions caused by placement of entry ports, packers, drill holes, or damage from removal of surface seal is not acceptable.
5. Grind off protrusions and patch indentations and holes from injection packers and entry ports with a suitable patch material to satisfaction of Engineer.
6. Remove surplus surface seal material splatters and injection resin material runs and spills from concrete surfaces.

3.05 FIELD QUALITY CONTROL

A. Epoxy Resin Two Component Ratio Tests:

1. Disconnect mixing head and pump two resin components simultaneously through ratio check device.

2. Adjust discharge pressure to 160 psi for both resin components.
3. Simultaneously discharge both resin components into separate calibrated containers.
4. Compare amounts simultaneously discharged into calibrated containers during same time period to determine mix ratio.
5. Complete test at 160 psi discharge pressure and repeat procedure for 0 psi discharge pressure.
6. Run ratio test for each injection unit at beginning and end of each injection work day, and when injection work has stopped for more than 1 hour.
7. Document and maintain complete accurate records of ratios and pressure checks.

B. Injection Pressure Test:

1. Disconnect mixing head of injection equipment and connect two resin component delivery lines to pressure check device.
2. Pressure Check Device:
 - a. Two independent valved nozzles capable of controlling flow rate and pressure by opening or closing of valve.
 - b. Pressure gauge capable of sensing pressure buildup behind each valve.
3. Close valves on pressure check device and operate equipment until gauge pressure on each line reads 160 psi.
4. Stop pumps and observe pressure; do not allow pressure gauge to drop below 150 psi within 3 minutes.
5. Run pressure test for each injection equipment unit:
 - a. Beginning and end of each injection work day.
 - b. When injection work stop for more than 45 minutes.
6. Check tolerance to verify equipment capable of meeting specified ratio tolerance.

C. Bottled Sample Tests:

1. During injection operation, provide at least one sample of mixed epoxy resin for each injection pump per shift per injection work day in a sample bottle.
2. Provide sufficient sample to demonstrate sample material epoxy resin will set and cure correctly.
3. Label each bottled sample with Contractor's name, date, and time sample was taken, and location in structure where sample was taken. Record details of bottle sample tests.
4. Place filled sample bottle upright in a container and allow sample to cure.

5. After sample has been allowed to cure, cut bottled sample open and visually inspect contents to verify that epoxy resin material has completely reacted and cured.
6. Evaluation and Assessment of Test:
 - a. Should bottled sample(s) indicate a problem; such as epoxy resin not cured or foreign liquid in sample bottle, take verifying core sample immediately from cracks, where material was used.
 - b. Should above-referenced bottle sample(s) and core sample(s) indicate a problem with epoxy resin, arrange to have a Technical Representative of the epoxy resin manufacturer come to Site to review bottled sample(s) and core drilled sample(s) with Engineer and provide technical advice on corrective measures.
 - c. Carry out further investigation work or corrective measures recommended by Technical Representative of epoxy resin manufacturer.

END OF SECTION

SECTION 03 64 24
POLYURETHANE INJECTION GROUTING

PART 1 GENERAL

1.01 REFERENCES

- A. The following is a list of standards that may be referenced in this section:
1. ASTM International (ASTM):
 - a. D638, Standard Test Method for Tensile Properties of Plastics.
 - b. D1622, Standard Test Method for Apparent Density of Rigid Cellular Plastics.
 - c. D1623, Standard Test Method for Tensile and Tensile Adhesion Properties of Rigid Cellular Plastics.
 - d. D3574, Standard Test Method for Flexible Cellular Material Slab, Bonded, and Molded Urethane Foams.

1.02 DEFINITIONS

- A. Crack: Complete or incomplete separation of concrete into two or more parts produced by breaking or fracturing.
- B. Injection: Method of bonding together; method of addressing or eliminating leakage through cracks or joints by installing polymer under pressure to fill the void in the crack or joint.
- C. Joint: A planned and formed discontinuity in the concrete structure at the junction of adjacent and sequential concrete placements, and may contain embedded waterstops.
- D. Leak or Leakage: Crack or joint exhibiting moisture, sign of efflorescence, intermittent wet to the touch, or continuous flow of liquid.
- E. Narrow Cracks: Width equal to or less than 0.015 inch.
- F. Wide Crack: Wider than 0.015 inch.

1.03 SUBMITTALS

- A. Action Submittals:
1. Physical and chemical properties for polyurethane injection resin.
 2. Technical data for metering, mixing, and injection equipment.
 3. Submit marked up drawings of proposed polyurethane injection work including locations, depth of penetration, length, materials used, and procedures.

4. Sample bottle.

B. Informational Submittals:

1. Manufacturer's recommended surface preparation procedures and application instructions for polyurethane resin injection.
2. Manufacturer's Certificate of Compliance in accordance with Section 01 61 00, Common Product Requirements. Certified test results for each batch of polyurethane.
3. Statements of Qualification for Polyurethane Resin Injection:
 - a. Manufacturer's Site representative.
 - b. Injection applicator.
 - c. Injection pump operating technician.
4. Sample of polyurethane resin mix ratio and injection pressure test records for concrete crack and joint injection work.
5. Installation instructions for repairing core holes with repair mortar.
6. Polyurethane resins injection pressure test records for concrete crack and joint injection work

1.04 QUALITY ASSURANCE

A. Qualifications for Injection Staff:

1. Manufacturer's Site Representative:
 - a. Capable of instructing successful methods of polyurethane injection process for concrete structures.
 - b. Understands and is capable of explaining technical aspects of correct material selection and use.
 - c. Experienced in the operation, maintenance, and troubleshooting of application equipment.
2. Injection crew and job foreman shall provide written and verifiable evidence showing compliance with the following requirements:
 - a. Licensed or certified by polyurethane resin manufacturer.
 - b. Minimum 3 years' experience in successful polyurethane injection for at least 10,000 linear feet of successful crack injection, including 2,000 linear feet of wet crack injection to stop water leakage.

1.05 PERFORMANCE REQUIREMENTS

- A. The injected polyurethane resin shall fill the cracks, and in no case shall the depth of penetration of the injection material be less than 90 percent of:
1. The full thickness of the concrete section for cracks.
 2. The depth between the waterstop and the inside face of the structure for joints.

- B. In cured state, injected polyurethane resin forms a dense rubber-like closed cell flexible foam compression gasket-type seal material.
- C. Notwithstanding the foregoing, injected cracks which exhibit leakage are considered deficient work irrespective of the depth of penetration observed in quality control core drilled samples. Reinject deficient work as required to meet the performance requirements.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Packing and Shipping:
 - 1. Package adhesive material in new sealed containers and label with following information:
 - a. Manufacturer's name.
 - b. Product name and lot number.
 - c. ANSI Hazard Classification (formerly SPI Classification).
 - d. ANSI recommended precautions for handling.
 - e. Mix ratio by volume for accelerator.
- B. Storage and Protection: Store polyurethane resin material containers in accordance with manufacturer's printed instructions or in the absence of such information at ambient temperatures below 110 degrees F and above 68 degrees F.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. BASF Construction Chemicals, LLC - Building Systems, Shakopee, MN; Masterinject 1210 IUG.
- B. Sika Corp., Lyndhurst, NJ; SikaFix HH Hydrophilic.
- C. Euclid Chemical Co., Cleveland, OH; DURAL Aqua-Fil.
- D. Prime Resins, Inc., Conyers, GA; Prime Flex 900 XLV.

2.02 POLYURETHANE RESIN

- A. Single-component, water-activated, hydrophilic polyurethane injection resin.
- B. Accelerator: Compatible with polyurethane resin from same manufacturer.
- C. Elongation: Minimum 350 percent, in accordance with ASTM D3574 or ASTM D638 test method.

- D. Tensile Strength: Minimum 150 psi, in accordance with ASTM D3574 or ASTM D638 test method.
- E. Shrinkage: Less than 2 percent.

2.03 SURFACE SEAL

- A. Provide seal with sufficient strength and adhesion for holding injection fittings firmly in place, and to resist pressures preventing leakage during injection.
- B. Capable of removal after injection resin has cured.

2.04 WATER

- A. Clean and free from oil, acid, alkali, organic matter, or other deleterious substances, meeting federal drinking water standards.

2.05 SAMPLE BOTTLE

- A. 5 inches natural wide mouth HDPE bottle or 4 ounces clear PVC cylinder bottle, supplied with caps.

2.06 SOURCE QUALITY CONTROL

- A. Test Requirements: Perform tests for each batch of polyurethane resins.

PART 3 EXECUTION

3.01 GENERAL

- A. Use of polyurethane injection shall be limited to nonstructural locations as determined by Structural Engineer.
- B. Do not proceed with injection work until action submittals have been reviewed and approved by the Structural Engineer of Record.
- C. Perform injection work after performing surface preparation.
- D. The width of the cracks shown may vary along the length and through the thickness of the concrete section.
- E. Remove all excess unused polyurethane resins materials inside the structure prior to the end of the work.

3.02 EQUIPMENT

- A. Portable, positive displacement type pumps with in-line metering to meter mixed components, and inject mixture into crack.

B. Pumps:

1. Positive displacement type pump.
2. Equip the polyurethane injection equipment with pail heater(s) suitable for plastic pails capable of maintaining the polyurethane resin and accelerator mixture between 50 degrees F and 160 degrees F.
3. A thermometer with each pump for monitoring the temperature of the polyurethane resin.

C. Discharge Pressure: Automatic pressure controls capable of discharging mixed polyurethane resin at pressures in accordance with polyurethane resin manufacturer's printed instructions, and able to maintain such pressure.

D. Proportioning Ratio Tolerance: Maintain polyurethane manufacturer's prescribed mix ratio within a tolerance in accordance with polyurethane resin manufacturer's printed instructions of plus or minus 5 percent by volume at discharge pressure up to 160 psi.

E. Pressure gauge capable of sensing pressure behind valve.

3.03 PREPARATION

A. Free cracks from loose matter, dirt, laitance, oil, grease, salt, and other contaminants.

B. Clean cracks in accordance with polyurethane resins manufacturer's printed instructions.

C. Clean surfaces adjacent to cracks from dirt, dust, grease, oil, efflorescence, encrustation, and other foreign matter detrimental to bond of surface seal system and to expose the full extent of cracks in accordance with manufacturer's printed instructions.

D. Do not use acids and corrosives for cleaning, other than those specified herein, unless neutralized prior to injecting polyurethane resin.

E. During installation and curing of materials, if the ambient temperature is expected to drop below the manufacturer's recommended minimum temperature, provide enclosures and heat as required.

F. Provide work platforms as required.

3.04 APPLICATION

A. Injection Ports:

1. Drill holes shall be installed along cracks designated for injection as required to meet the performance requirements for injection.

2. The requirements for installing drill holes for injection provided below represent acceptable minimum standards of practice.
3. Drill holes for injection at an angle between 45 degrees and 60 degrees from the surface of the concrete and perpendicular to the cracks alignment, to intersect the cracks at the midpoint of the concrete section, and intersect the joints at the midpoint between the waterstop and interior concrete surface, except as noted otherwise.
4. Locate drill holes on alternate sides of the crack where possible, unless orientation of the crack is known or has been verified by nondestructive testing techniques or core drilling.
5. The spacing of drill holes not to exceed the concrete thickness or 12 inches (maximum), except as noted otherwise.
6. Adjust location and angle of drill holes to suit orientation of crack and at required angle, such as using a template, during the Work especially at the commencement of drilling holes for injection and at the beginning of each subsequent shift.
7. Take measures to prevent drilling holes for injection too shallow, or too deep, and/or damaging the existing waterstop in the joints. Shallow hole injections lead to concrete spalls. Repair spalls at Contractor's expense.
8. Remove dust and debris in drill holes and on interior surface of the structure resulting from drilling operation, by flushing with water prior to installing injection packers or ports.
9. Install injection packers or ports in drill holes in accordance with manufacturer's printed instructions with zerk coupling, or other one-way ball or check valve, to permit testing for watertightness and acid flushing of cracks and joints.

B. Application of Surface Seal Along Cracks:

1. Apply surface seal along the length of the cracks designated for injection on the top side and underside of slabs, or both sides of walls, where possible in order to contain, confine, and prevent escape of the injected polyurethane resin, in accordance with manufacturer's printed instructions.
2. Cure the surface seal in accordance with the material's manufacturer's printed instructions.

C. Mixing Polyurethane Injection Resin:

1. Add accelerator to polyurethane injection resin at the required dosage to produce cured polyurethane material meeting performance requirements, and mix thoroughly in accordance with manufacturer's printed instructions until a homogeneous mixture is obtained outside of the structure.

2. Heat polyurethane injection resin materials prior to and during mixing and injection as required and in accordance with manufacturer's printed instructions to a temperature between 85 degrees F and 130 degrees F. Injection of polyurethane resin when it is less than 85 degrees F or more than 130 degrees F is prohibited.

D. Polyurethane Injection of Cracks:

1. Inject polyurethane resins, mixed with accelerator or in a neat form, into cracks in a sequential manner, and reinjection as required, to meet the performance requirements.
2. Start injection into each crack at lowest elevation entry port for vertical or diagonal cracks and at one end for horizontal cracks in vertical structure. Continue injection at first port until pure uncontaminated resin begins to flow out of next port. Plug first port and start injection at second port until polyurethane resin flows from next port. Inject crack in a sequential manner until the full length of the crack has been injected. At no time inject more than 6 feet length of vertical crack before verifying that the first 12 inches of injected crack is set and cured.
3. Prior to commencing the injection work along a crack in horizontal structure when packers with zerk couplings are used, remove the zerk couplings from the injection packers or ports except for the two packers located where the injection work will commence. Commence injection work in the first two packers. Once clean resin is vented from the third injection packer, cease injection at the first packer, and install the zerk coupling and commence injection at the third packer. Repeat the process for the fourth and subsequent packers until the full length of the crack has been injected.

E. Finishing:

1. Cure polyurethane resins after crack has been completely filled without draining or runback of polyurethane resin material from crack.
2. Remove surface seal and injection packers or ports from along the crack.
3. Finish surface flush and to match surrounding concrete.
4. Indentations or protrusions caused by placement of entry ports drill holes, or damage from removal of surface seal, is not acceptable.
5. Grind off protrusions, and patch indentations and holes from packers and ports with a suitable patch material to the satisfaction of the Engineer.
6. Remove surplus surface seal material on splatters and injection material runs and spills from concrete surfaces.

3.05 FIELD QUALITY CONTROL

A. Injection Pressure Test:

1. Disconnect mixing head of injection equipment and connect polyurethane component delivery line to pressure check device.
2. Pressure Check Device:
 - a. Two independent valved nozzles capable of controlling flow rate and pressure by opening or closing of valve.
 - b. Pressure gauge capable of sensing pressure buildup behind each valve.
3. Close valves on pressure check device and operate equipment until gauge pressure on each line reads 160 psi.
4. Stop pumps and observe pressure; do not allow pressure gauge to drop below 150 psi within 3 minutes.
5. Run pressure Test for Each Injection Equipment Unit:
 - a. Beginning and end of each injection work day.
 - b. When injection work has stopped for more than 45 minutes.
6. Check tolerance to verify equipment capable of meeting specified ratio tolerance.

B. Bottled Samples:

1. During the injection operation, provide at least one sample of the mixed polyurethane injection resins per shift per injection pump in a sample bottle.
2. Half fill each sample bottle, containing a small amount of water (5 percent by volume) with polyurethane injection resin material from the pump discharge hose. Swirl or lightly shake sample to thoroughly mix resin with the water. When foaming rises near the top of the bottle, install the cap to contain the expanding resin material.
3. Label each bottled sample with Contractor's name, date and time sample was taken, and location in structure where sample was taken. Maintain a log of bottle samples.
4. Place filled sample bottle upright in a box or pail and allow sample to cure.
5. After sample cured, cut bottled sample open and visually inspect contents to verify that polyurethane injection resins material has completely reacted and cured.
6. Evaluation and Assessment of Test:
 - a. If a bottled sample(s) indicates a problem with the polyurethane injection resins, such as polyurethane resin not cured; take verifying core sample immediately from the cracks, where the material was used.

- b. If the above-referenced bottle sample(s) and core sample(s) indicate a problem with the polyurethane injection resins, have a Technical Representative of the polyurethane injection resins manufacturer come to site to review bottled sample(s) and core drilled sample(s) with Engineer and provide technical advice on corrective measures.
- c. Carry out further investigation work or corrective measures recommended by the Technical Representative of the polyurethane injection resins manufacturer.

END OF SECTION

SECTION 05 05 19
POST-INSTALLED ANCHORS

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American Concrete Institute (ACI):
 - a. 318, Building Code Requirements for Structural Concrete.
 - b. 355.2, Qualification of Post-Installed Mechanical Anchors in Concrete.
 - c. 355.4, Qualification of Post-Installed Adhesive Anchors in Concrete.
2. American Iron and Steel Institute (AISI): Stainless Steel Type 316.
3. American National Standards Institute (ANSI).
4. ASTM International (ASTM):
 - a. A123/A123M, Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
 - b. A143, Practice for Safeguarding Against Embrittlement of Hot-Dip Galvanized Structural Steel Products and Procedure for Detecting Embrittlement.
 - c. A153/A153M, Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
 - d. A193/A193M, Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service.
 - e. A194/A194M, Specification for Carbon and Alloy Steel Nuts for Bolts for High-Pressure or High-Temperature Service, or Both.
 - f. A380, Practice for Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment, and Systems.
 - g. A385, Practice for Providing High-Quality Zinc Coatings (Hot-Dip).
 - h. A563, Specification for Carbon and Alloy Steel Nuts.
 - i. A780, Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings.
 - j. A967, Specification for Chemical Passivation Treatments for Stainless Steel Parts.
 - k. E488, Standard Test Methods for Strength of Anchors in Concrete Elements.
 - l. F436, Specification for Hardened Steel Washers.
 - m. F468, Specification for Nonferrous Bolts, Hex Cap Screws, and Studs for General Use.
 - n. F568M, Specification for Carbon and Alloy Steel Externally Threaded Metric Fasteners.

- o. F593, Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.
- p. F594, Specification for Stainless Steel Nuts.
- q. F1554, Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength.
- 5. International Association of Plumbing and Mechanical Officials Uniform ES (IAPMO-UES): Evaluation Reports for Concrete and Masonry Anchors.
- 6. International Code Council Evaluation Service (ICC-ES):
 - a. Evaluation Reports for Concrete and Masonry Anchors.
 - b. AC01, Acceptance Criteria for Expansion Anchors in Masonry Elements.
 - c. AC70, Acceptance Criteria for Fasteners Power-driven into Concrete, Steel and Masonry Elements.
 - d. AC106, Acceptance Criteria for Predrilled Fasteners (Screw Anchors) in Masonry Elements.
 - e. AC193, Acceptance Criteria for Mechanical Anchors in Concrete Elements.
 - f. AC308, Acceptance Criteria for Post-Installed Adhesive Anchors in Concrete Elements. Evaluation Reports for Concrete and Masonry Anchors.
- 7. NSF International (NSF): 61, Drinking Water System Components - Health Effects.
- 8. Specialty Steel Industry of North America (SSINA):
 - a. Specifications for Stainless Steel.
 - b. Design Guidelines for the Selection and Use of Stainless Steel.
 - c. Stainless Steel Fabrication.
 - d. Stainless Steel Fasteners.

1.02 DEFINITIONS

- A. Corrosive Area: Containment area or area exposed to delivery, storage, transfer, or use of chemicals.
- B. Exterior Area: Location not protected from weather by a building or other enclosed structure to include buried roof structures.
- C. Interior Dry Area: Location inside building or structure where floor is not subject to liquid spills or wash down, and where wall or roof slab is not common to a water-holding or earth-retaining structure.
- D. Interior Wet Area: Location inside building or structure where floor is sloped to floor drains or gutters and is subject to liquid spills or wash down, or where wall, floor, or roof slab is common to a water-holding or earth-retaining structure.

- E. Submerged: Location at or below top of wall of open water-holding structure, such as a basin or channel, or wall, ceiling, or floor surface inside a covered water-holding structure, or exterior belowgrade wall or roof surface of water-holding structure, open or covered.

1.03 SUBMITTALS

A. Action Submittals:

- 1. Shop Drawings: Specific instructions for concrete anchor installation, including drilled hole size and depth, preparation, placement, procedures, and instructions for safe handling of anchoring systems.

B. Informational Submittals:

- 1. Concrete Anchors:
 - a. Manufacturer's product description and installation instructions.
 - b. Current ICC-ES or IAPMO-UES Report for each type of post-installed anchor to be used.
 - c. Adhesive Anchor Installer Certification.
- 2. Passivation method for stainless steel members.
- 3. Hot-Dip Galvanizing: Certificate of Compliance signed by galvanizer, with description of material processed and ASTM standard used for coating.

1.04 QUALITY ASSURANCE

A. Qualifications:

- 1. Installers of adhesive anchors horizontally or upwardly inclined to support sustained tension loads shall be certified by an applicable certification program. Certification shall include written and performance tests in accordance with the ACI/CRSI Adhesive Installer Certification Program or equivalent.
- 2. Galvanized Coating Applicator: Company specializing in hot-dip galvanizing after fabrication and following procedures of Quality Assurance Manual of the American Galvanizers Association.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Package stainless steel items in a manner to provide protection from carbon impregnation.
- B. Protect hot-dip galvanized finishes from damage as a result of metal banding and rough handling.

PART 2 PRODUCTS**2.01 GENERAL**

A. Unless otherwise indicated, meet the following requirements:

Item	ASTM Reference
Stainless Steel:	
Threaded Rods	F593, AISI Type 316, Condition CW
Nuts*	F594, AISI Type 316, Condition CW
Carbon Steel:	
Threaded Rods	F1554, Grade 36 or F568M Class 5.8 (A193/A193M, Grade B7)
Flat and Beveled Washers (Hardened)	F436
Nuts*	A194/A194M, Grade 2H
Galvanized Steel:	
All	A153/A153M
*Nuts of other grades and styles having specified proof load stresses greater than specified grade and style are also suitable. Nuts must have specified proof load stresses equal to or greater than minimum tensile strength of specified threaded rod.	

B. Bolts, Washers, and Nuts: Use stainless steel, hot-dip galvanized steel, and zinc-plated steel material types as indicated in Fastener Schedule at end of this section.

2.02 POST-INSTALLED CONCRETE ANCHORS

A. General:

1. AISI Type 316 stainless, hot-dip galvanized or zinc-plated steel, as shown in Fastener Schedule at end of this section.
2. Post-installed anchor systems used in concrete shall be approved by ICC Evaluation Services Report or equivalent for use in cracked concrete and for short-term and long-term loads including wind and earthquake.
3. Mechanical Anchors: Comply with the requirements of ICC-ES AC193 or ACI 355.2.
4. Adhesive Anchors: Comply with the requirements of ICC-ES AC308 or ACI 355.4.
5. Acceptable for use in potable water structures by EPA and local health agencies or NSF 61.

B. Torque-Controlled Expansion Anchors (Wedge Anchors):

1. Manufacturers and Products:
 - a. Hilti, Inc., Tulsa, OK; Kwik-Bolt –TZ (KB-TZ) Anchors (ESR-1917).
 - b. DeWalt/Powers Fasteners, Brewster, NY; Power-Stud +SD1 , +SD2, +SD4, or +SD6 Anchors (ESR-2502 and ESR-2818).
 - c. Simpson Strong-Tie Co., Inc., Pleasanton, CA; Strong-Bolt 2 Anchors (ESR-1771 and ESR-3037).

C. Adhesive Anchors:

1. Threaded Rod:
 - a. Diameter as shown on Drawings.
 - b. Length as required to provide minimum depth of embedment indicated and thread projection required.
 - c. Clean and free of grease, oil, or other deleterious material.
2. Adhesive:
 - a. Two-component, insensitive to moisture, designed to be used in adverse freeze/thaw environments.
 - b. Cure Temperature, Pot Life, and Workability: Compatible for intended use and anticipated environmental conditions.
3. Packaging and Storage:
 - a. Disposable, self-contained system capable of dispensing both components in proper mixing ratio and fitting into a manually or pneumatically operated caulking gun.
 - b. Store adhesive on pallets or shelving in a covered storage area.
 - c. Package Markings: Include manufacturer's name, product name, batch number, product expiration date, ANSI hazard classification, and appropriate ANSI handling precautions.
 - d. Dispose of When:
 - 1) Shelf life has expired.
 - 2) Stored other than in accordance with manufacturer's instructions.
4. Manufacturers and Products:
 - a. Hilti, Inc., Tulsa, OK; HIT Doweling Anchor System, HIT RE 500 V3 (ESR-3814), or HIT-HY 200 (ESR-3187).
 - b. Simpson Strong-Tie Co., Inc., Pleasanton, CA; SET-XP Epoxy Adhesive Anchors (ESR-2508), or AT-XP Adhesive Anchors (IAPMO UES-263).
 - c. DeWalt/Powers Fasteners, Brewster NY; Pure 110+ Epoxy adhesive anchor system (ESR-3298).

D. Adhesive Threaded Inserts:

1. Type 316 stainless steel, internally threaded inserts.
2. Manufacturer and Product: Hilti, Inc., Tulsa, OK; HIS-RN Insert with HIT-RE 500-V3 or HIT-HY 200 adhesive.

PART 3 EXECUTION

3.01 CONCRETE ANCHORS

- A. Begin installation only after concrete to receive anchors has attained design strength.
- B. Locate existing reinforcing with Ground Penetrating Radar or other method approved by Engineer prior to drilling. Coordinate with Engineer to adjust anchor locations where installation would result in hitting reinforcing.
- C. Install in accordance with written manufacturer's instructions.
- D. Provide minimum embedment, edge distance, and spacing as indicated on Drawings.
- E. Use only drill type and bit type and diameter recommended by anchor manufacturer.
- F. Clean hole of debris and dust per manufacturer's requirements.
- G. When unidentified embedded steel, rebar, or other obstruction is encountered in drill path, slant drill to clear obstruction. If drill must be slanted more than indicated in manufacturer's installation instructions to clear obstruction, notify Engineer for direction on how to proceed.
- H. Adhesive Anchors:
 1. Unless otherwise approved by Engineer and adhesive manufacturer:
 - a. Do not install adhesive anchors when temperature of concrete is below 40 degrees F or above 100 degrees F.
 - b. Do not install prior to concrete attaining an age of 21 days.
 - c. Remove any standing water from hole with oil-free compressed air. Inside surface of hole shall be dry.
 - d. Do not disturb anchor during recommended curing time.
 - e. Do not exceed maximum torque as specified in manufacturer's instructions.

3.02 FIELD QUALITY ASSURANCE AND QUALITY CONTROL

- A. Owner-Furnished Quality Assurance, in accordance with IBC Chapter 17 requirements, is provided in the Statement of Special Inspections Plan in Supplement located at end of Section 01 45 33, Special Inspection, Observation, and Testing. Contractor responsibilities and related information are included in Section 01 45 33, Special Inspection, Observation, and Testing.
- B. Contractor-Furnished Quality Control: Inspection and testing as required in Section 01 45 16.13, Contractor Quality Control.

3.03 MANUFACTURER'S SERVICES

- A. Adhesive and Mechanical Anchors: Conduct Site training of installation personnel for proper installation, handling, and storage of adhesive anchor system. Notify Engineer of time and place for sessions.

3.04 FASTENER SCHEDULE

- A. Unless indicated otherwise on Drawings, provide fasteners as follows:

Service Use and Location	Product	Remarks
1. Post-Installed Anchors for Metal Components to Cast-in-Place Concrete (such as, Ladders, Handrail Posts, Electrical Panels, Platforms, and Equipment)		
Interior Dry Areas	Anchor material type to match material being anchored (for example, stainless steel anchors to anchor stainless steel equipment, zinc-plated anchors to anchor painted equipment, galvanized anchors to anchor galvanized equipment).	Verify product acceptability and manufacturer's requirements if anchor installation will occur in an overhead application
Submerged, Exterior, Interior Wet, and Corrosive Areas	Stainless steel adhesive anchors	Verify product acceptability and manufacturer's requirements if anchor installation will occur in an overhead application
2. All Others		
All service uses and locations	Stainless steel fasteners	

- B. Antiseizing Lubricant: Use on all stainless steel threads.
- C. Do not use adhesive anchors to support fire-resistive construction or where ambient temperature will exceed 120 degrees F.

END OF SECTION

SECTION 05 50 00 METAL FABRICATIONS

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. The Aluminum Association, Inc. (AA): The Aluminum Design Manual.
2. American Galvanizers Association (AGA):
 - a. Inspection of Hot-Dip Galvanized Steel Products.
 - b. Quality Assurance Manual.
3. American Iron and Steel Institute (AISI): Stainless Steel Types.
4. American Ladder Institute (ALI): A14.3, Ladders - Fixed - Safety Requirements.
5. American National Standards Institute (ANSI).
6. American Welding Society (AWS):
 - a. D1.1/D1.1M, Structural Welding Code - Steel.
 - b. D1.2/D1.2M, Structural Welding Code - Aluminum.
 - c. D1.6/D1.6M, Structural Welding Code - Stainless Steel.
7. ASTM International (ASTM):
 - a. A36/A36M, Standard Specification for Carbon Structural Steel.
 - b. A53/A53M, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
 - c. A108, Standard Specification for Steel Bar, Carbon and Alloy, Cold-Finished.
 - d. A193/A193M, Standard Specification for Alloy-Steel and Stainless Steel Bolting for High Temperature or High Pressure Service and Other Special Purpose Applications.
 - e. A194/A194M, Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both.
 - f. A276, Standard Specification for Stainless Steel Bars and Shapes.
 - g. A283/A283M, Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates.
 - h. A307, Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.
 - i. A325, Standard Specification for Structural Bolts, Steel, Heat Treated 120/105 ksi Minimum Tensile Strength.
 - j. A380, Standard Practice for Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment, and Systems.
 - k. A563, Standard Specification for Carbon and Alloy Steel Nuts.
 - l. A786/A786M, Standard Specification for Hot-Rolled Carbon, Low-Alloy, High-Strength Low-Alloy, and Alloy Steel Floor Plates.

- m. A793, Standard Specification for Rolled Floor Plate, Stainless Steel.
- n. A992/A992M, Standard Specification for Structural Steel Shapes.
- o. B308/B308M, Standard Specification for Aluminum-Alloy 6061-T6 Standard Structural Profiles.
- p. B429/B429M, Standard Specification for Aluminum-Alloy Extruded Structural Pipe and Tube.
- q. B632/B632M, Standard Specification for Aluminum-Alloy Rolled Tread Plate.
- r. C881/C881M, Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete.
- s. F436, Standard Specification for Hardened Steel Washers.
- t. F468, Standard Specification for Nonferrous Bolts, Hex Cap Screws, and Studs for General Use.
- u. F593, Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.
- v. F594, Standard Specification for Stainless Steel Nuts.
- w. F844, Standard Specification for Washers, Steel, Plain (Flat), Unhardened for General Use.
- x. F1554, Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength.
- 8. Occupational Safety and Health Administration (OSHA):
 - a. 29 CFR 1910.27, Fixed Ladders.
 - b. 29 CFR 1926.105, Safety Nets.
 - c. 29 CFR 1926.502, Fall Protection Systems Criteria and Practices.
- 9. Specialty Steel Industry of North America (SSINA):
 - a. Specifications for Stainless Steel.
 - b. Design Guidelines for the Selection and Use of Stainless Steel.
 - c. Stainless Steel Fabrication.
 - d. Stainless Steel Fasteners.

1.02 DEFINITIONS

- A. Anchor Bolt: Cast-in-place anchor; concrete or masonry.
- B. Corrosive Area: Containment area or area exposed to delivery, storage, transfer, or use of chemicals. Corrosive area includes areas exposed to corrosive atmosphere such as hydrogen sulfide from wastewater.
- C. Exterior Area: Location not protected from weather by building or other enclosed structure.
- D. Interior Dry Area: Location inside building or structure where floor is not subject to liquid spills or washdown, nor where wall or roof slab is common to a water-holding or earth-retaining structure.

- E. Interior Wet Area: Location inside building or structure where floor is sloped to floor drains or gutters and is subject to liquid spills or washdown, or where wall, floor, or roof slab is common to a water-holding or earth-retaining structure.
- F. Submerged: Location at or below top of wall of open water-holding structure, such as basin or channel, or wall, ceiling or floor surface inside a covered water-holding structure, or exterior belowgrade wall or roof surface of water-holding structure, open or covered.

1.03 SUBMITTALS

A. Action Submittals:

- 1. Shop Drawings: Metal fabrications, including welding and fastener information.
- 2. Samples: Color samples of abrasive stair nosings.

B. Informational Submittals:

- 1. Passivation method for stainless steel members.
- 2. Galvanized coating applicator qualifications.
- 3. Hot-Dip Galvanizing: Certificate of compliance signed by galvanizer, with description of material processed and ASTM standard used for coating.

1.04 QUALITY ASSURANCE

A. Qualifications:

- 1. Galvanized Coating Applicator: Company specializing in hot-dip galvanizing after fabrication and following procedures of Quality Assurance Manual of the American Galvanizers Association.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Insofar as practical, factory assemble specified items. Package assemblies, which have to be shipped unassembled to protect materials from damage and tag to facilitate identification and field assembly.
- B. Package stainless steel items to provide protection from carbon impregnation.
- C. Protect painted coatings and hot-dip galvanized finishes from damage as a result of metal banding and rough handling. Use padded slings and straps.
- D. Store fabricated items in dry area, not in direct contact with ground.

PART 2 PRODUCTS**2.01 GENERAL**

- A. For hot-dip galvanized steel that is exposed to view and does not receive paint, limit the combined phosphorus and silicon content to 0.04 percent. For steels that require a minimum of 0.15 percent silicon (such as plates over 1.5 inches thick for ASTM A36/A36M steel), limit maximum silicon content to 0.21 percent and phosphorous content to 0.03 percent.
- B. Unless otherwise indicated, meet the following requirements:

Item	ASTM Reference
Steel Wide Flange Shapes	A992/992M
Other Steel Shapes and Plates	A36/A36M or A572/A572M, Grade 50 or A992/A992M for other steel shapes
Aluminum:	
Aluminum Plates	B209, Alloy 6061-T6
Aluminum Structural Shapes	B308/B308M, Alloy 6061-T6
Stainless Steel:	
Bars and Angles	A276, AISI Type 316 (Type 316L for welded connections)
Shapes	A276, AISI Type 304 (Type 304L for welded connections)
Steel Plate, Sheet, and Strip	A240/A240M, AISI Type 316 (Type 316L for welded connections)
Bolts, Threaded Rods, Anchor Bolts, and Anchor Studs	F593, AISI Type 316, Group 2, Condition SH
Nuts	F594, AISI Type 316, Condition CW
Steel Bolts and Nuts:	
Carbon Steel	A307 bolts, with A563 nuts
High-Strength	A325, Type 1 bolts, with A563 nuts
Anchor Bolts and Rods	F1554, Grade 55, with weldability supplement S1.
Eyebolts	A489
Threaded Rods	A36/A36M

Item	ASTM Reference
Flat Washers (Unhardened)	F844
Flat and Beveled Washers (Hardened)	F436

- C. Bolts, Washers, and Nuts: Use stainless steel, hot-dip galvanized steel, zinc-plated steel, and aluminum material types as indicated in Fastener Schedule at end of this section.

2.02 ANCHOR BOLTS AND ANCHOR BOLT SLEEVES

A. Cast-In-Place Anchor Bolts:

1. Headed type, unless otherwise shown on Drawings.
2. Material type and protective coating as shown in Fastener Schedule at end of this section.

B. Anchor Bolt Sleeves:

1. Plastic:
 - a. Single unit construction with corrugated sleeve.
 - b. Top of sleeve shall be self-threading to provide adjustment of threaded anchor bolt projection.
 - c. Material: High-density polyethylene.
2. Fabricated Steel: ASTM A36/A36M.

2.03 POST-INSTALLED CONCRETE ANCHORS

- A. See Section 05 05 19, Post-Installed Anchors.

2.04 ACCESSORIES

A. Antiseizing Lubricant for Stainless Steel Threaded Connections:

1. Suitable for potable water supply.
2. Resists washout.
3. Manufacturers and Products:
 - a. Bostik, Middleton, MA; Neverseez.
 - b. Saf-T-Eze Div., STL Corp., Lombard, IL; Anti-Seize.

2.05 FABRICATION

A. General:

1. Finish exposed surfaces smooth, sharp, and to well-defined lines.
2. Furnish necessary rabbets, lugs, and brackets so work can be assembled in neat, substantial manner.

3. Conceal fastenings where practical; where exposed, flush countersink.
4. Drill metalwork and countersink holes as required for attaching hardware or other materials.
5. Grind cut edges smooth and straight. Round sharp edges to small uniform radius. Grind burrs, jagged edges, and surface defects smooth.
6. Fit and assemble in largest practical sections for delivery to Site.

B. Materials:

1. Use steel shapes, unless otherwise noted.
2. Steel to be hot-dip galvanized: Limit silicon content to less than 0.04 percent or to between 0.15 percent and 0.25 percent.
3. Fabricate aluminum in accordance with AA Specifications for Aluminum Structures—Allowable Stress Design.

C. Welding:

1. Weld connections and grind exposed welds smooth. When required to be watertight, make welds continuous.
2. Welded fabrications shall be free from twisting or distortion caused by improper welding techniques.
3. Steel: Meet fabrication requirements of AWS D1.1/D1.1M, Section 5.
4. Aluminum: Meet requirements of AWS D1.2/D1.2M.
5. Stainless Steel: Meet requirements of AWS D1.6/D1.6M.
6. Welded Anchor Studs: Prepare surface to be welded and weld with stud welding gun in accordance with AWS D1.1/D1.1M, Section 7, and manufacturer's instructions.
7. Complete welding before applying finish.

D. Painting:

1. Shop prime with rust-inhibitive primer as specified in Section 09 90 00, Painting and Coating, unless otherwise indicated.
2. Coat surfaces of galvanized steel and aluminum fabricated items to be in direct contact with concrete, grout, masonry, or dissimilar metals, as specified in Section 09 90 00, Painting and Coating, unless indicated otherwise.
3. Do not apply protective coating to galvanized steel anchor bolts or galvanized steel welded anchor studs, unless indicated otherwise.

E. Galvanizing:

1. Fabricate steel to be galvanized in accordance with ASTM A143/A143M, ASTM A384/A384M, and ASTM A385/A385M. Avoid fabrication techniques that could cause distortion or embrittlement of the steel.

2. Provide venting and drain holes for tubular members and fabricated assemblies in accordance with ASTM A385/A385M.
 3. Remove welding slag, splatter, burrs, grease, oil, paint, lacquer, and other deleterious material prior to delivery for galvanizing.
 4. Remove by blast cleaning or other methods surface contaminants and coatings not removable by normal chemical cleaning process in the galvanizing operation.
 5. Hot-dip galvanize steel members, fabrications, and assemblies after fabrication in accordance with ASTM A123/A123M.
 6. Hot-dip galvanize bolts, nuts, washers, and hardware components in accordance with ASTM A153/A153M. Oversize holes to allow for zinc alloy growth. Shop assemble bolts and nuts.
 7. Galvanized steel sheets in accordance with ASTM A653/A653M.
 8. Galvanize components of bolted assemblies separately before assembly. Galvanizing of tapped holes is not required.
- F. Electrolytic Protection: Coat surfaces of galvanized steel and aluminum fabricated items to be in direct contact with concrete, grout, masonry, or dissimilar metals, as specified in Section 09 90 00, Painting and Coating, unless indicated otherwise.
- G. Fitting: Where movement of fabrications is required or shown, cut, fit, and align items for smooth operation. Make corners square and opposite sides parallel.
- H. Accessories: Furnish as required for a complete installation. Fasten by welding or with stainless steel bolts or screws.

2.06 SOURCE QUALITY CONTROL

- A. Visually inspect all fabrication welds and correct deficiencies.
1. Steel: AWS D1.1/D1.1M, Section 6 and Table 6.1, Visual Inspection Acceptance Criteria.
 2. Aluminum: AWS D1.2/D1.2M.
 3. Stainless Steel: AWS D1.6/D1.6M.

PART 3 EXECUTION

3.01 INSTALLATION OF METAL FABRICATIONS

- A. General:
1. Install metal fabrications plumb and level, accurately fitted, free from distortion or defects.
 2. Install rigid, substantial, and neat in appearance.

3. Install manufactured products in accordance with manufacturer's recommendations.
4. Obtain Engineer approval prior to field cutting steel members or making adjustments not scheduled.

B. Aluminum:

1. Do not remove mill markings from concealed surfaces.
2. Remove inked or painted identification marks on exposed surfaces not otherwise coated after installed material has been inspected and approved.
3. Fabrication, mechanical connections, and welded construction shall be in accordance with the AA Aluminum Design Manual.

3.02 CAST-IN-PLACE ANCHOR BOLTS

- A. Locate and hold anchor bolts in place with templates at time concrete is placed.
- B. Use anchor bolt sleeves for location adjustment and provide two nuts and one washer per bolt of same material as bolt.
- C. Minimum Bolt Size: 1/2-inch diameter by 12 inches long, unless otherwise shown.

3.03 ELECTROLYTIC PROTECTION

A. Aluminum and Galvanized Steel:

1. Coat surfaces of galvanized steel and aluminum fabricated items to be in direct contact with concrete, grout, masonry, or dissimilar metals, as specified in Section 09 90 00, Painting and Coating, unless indicated otherwise.
2. Do not apply protective coating to galvanized steel anchor bolts or galvanized steel welded anchor studs, unless indicated otherwise.
3. Allow coating to dry before installation of the material.
4. Protect coated surfaces during installation.
5. Should coating become marred, prepare and touch up in accordance with paint manufacturer's written instructions.

- B. Titanium: Where titanium equipment is in contact with concrete or dissimilar metal, provide full-face neoprene insulation gasket, 3/32-inch minimum thickness and 70-durometer hardness.

C. Stainless Steel:

1. During handling and installation, take necessary precautions to prevent carbon impregnation of stainless steel members.

2. After installation, visually inspect stainless steel surfaces for evidence of iron rust, oil, paint, and other forms of contamination.
3. Remove contamination using cleaning and passivation methods in accordance with requirements of ASTM A380 and ASTM A967.
4. Brushes used to remove foreign substances shall utilize only stainless steel or nonmetallic bristles.
5. After treatment, visually inspect surfaces for compliance.

3.04 PAINTING

- A. Painted Galvanized Surfaces: Prepare as specified in Section 09 90 00, Painting and Coating.
- B. Repair of Damaged Hot-Dip Galvanized Coating:
 1. Conform to ASTM A780/A780M.
 2. For minor repairs at abraded areas, use sprayed zinc conforming to ASTM A780/A780M.
 3. For flame cut or welded areas, use zinc-based solder, or zinc sticks, conforming to ASTM A780/A780M.
 4. Use magnetic gauge to determine thickness is equal to or greater than base galvanized coating.
- C. Field Painting of Shop Primed Surfaces: Prepare surfaces and field finish in accordance with Section 09 90 00, Painting and Coating.

3.05 FIELD QUALITY ASSURANCE AND QUALITY CONTROL

- A. Owner-Furnished Quality Assurance:
 1. In accordance with IBC Chapter 17 requirements, is provided in the Statement of Special Inspections Plan in Supplement located at end of Section 01 45 33, Special Inspection, Observation, and Testing.
 2. Contractor responsibilities and related information on special inspection, observation, and testing are included in Section 01 45 33, Special Inspection, Observation, and Testing.
- B. Contractor-Furnished Quality Control:
 1. Inspection and testing required in Section 01 45 16.13, Contractor Quality Control.
 2. Manufacturer's Certificate of Compliance per Section 01 61 00, Common Product Requirements, for test results, or calculations, or drawings that ensure material and equipment design and design criteria meet requirements of Section 01 61 00, Common Product Requirements and Section 01 88 15, Anchorage and Bracing.

3.06 FASTENER SCHEDULE

A. Unless indicated otherwise on Drawings, provide fasteners as follows:

Service Use and Location	Product	Remarks
1. Anchor Bolts Cast Into Concrete for Structural Steel, Metal Fabrications and Castings		
Interior Dry Areas	Hot-dip galvanized steel headed anchor bolts, unless indicated otherwise	
Exterior and Interior Wet Areas, Submerged and Corrosive Areas	Stainless steel headed anchor bolts	
2. Anchor Bolts Cast Into Concrete for Equipment Bases		
Interior Dry Areas	Hot-dip galvanized steel headed anchor bolts, unless otherwise specified with equipment	
Submerged, Exterior, Interior Wet, and Corrosive Areas	Stainless steel headed anchor bolts with fusion bonded coating, unless otherwise specified with equipment	See Section 09 90 00, Painting and Coating
3. Post-Installed Anchors: See Section 05 05 19, Post-Installed Anchors		
4. Connections of Aluminum Components		
Submerged, Exterior and Interior Wet and Dry Areas	Stainless steel bolted connections, unless otherwise specified with equipment	
5. All Others		
Exterior and Interior Wet and Dry Areas	Stainless steel fasteners	

B. Antiseizing Lubricant: Use on stainless steel threads.

END OF SECTION

SECTION 06 82 00
GLASS-FIBER-REINFORCED PLASTIC

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. ASTM International (ASTM):
 - a. C177, Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded Hot-Plate Apparatus.
 - b. D570, Standard Test Method for Water Absorption of Plastics.
 - c. D635, Standard Test Method for Rate of Burning and/or Extent and Time of Burning Plastics in a Horizontal Position.
 - d. D638, Standard Test Method for Tensile Properties of Plastics.
 - e. D695, Standard Test Method for Compressive Properties of Rigid Plastics.
 - f. D696, Standard Test Method for Coefficient of Linear Thermal Expansion of Plastics Between -30 Degrees C and 30 Degrees C.
 - g. D790, Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.
 - h. D792, Standard Test Methods for Density and Specific Gravity (Relative Density) by Plastics Displacement.
 - i. D2344, Standard Test Method for Apparent Interlaminar Shear Strength of Parallel Fiber Composites by Short-Beam Method.
 - j. D2583, Standard Test Method for Indentation Hardness of Rigid Plastics by Means of a Barcol Impressor.
 - k. E84, Standard Test Method for Surface Burning Characteristics of Building Materials.
2. Occupational Safety and Health Act (OSHA): 29 CFR 19.10, Code of Federal Regulations.
3. Underwriters' Laboratories, Inc. (UL): 94, UL Standard for Safety Test for Flammability of Plastic Materials for Parts in Devices and Appliances.

1.02 DESIGN REQUIREMENTS

A. This section contains components and connectors that require Contractor design.

1.03 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
 - a. Product Data: Catalog information and catalog cuts showing materials, design tasks, and showing load, span, and deflection; include manufacturer's specifications.
 - b. Grating: Show dimensions, weight, size, and location of connections to adjacent grating, supports, and other Work.
 - c. Grating Supports: Show dimensions, weight, size, location, and anchorage to supporting structure.
 - d. Stairs, Platforms, Stringers, Handrails, Ladders, and Support Structures:
 - 1) Show dimensions, weight, size, and location of connections to adjacent supports and other Work.
 - 2) Structural calculations for platforms, ladders and cages, handrails, and other fabrications shown.
2. Samples: Each type of grating, handrail, and handrail connection.

B. Informational Submittals:

1. Handling and storage requirements.
2. Manufacturer's installation instructions.
3. Factory test reports for physical properties of product.
 - a. Test data for handrails and supports may supplement load calculations providing data covers the complete system, including anchorage.
 - b. Test data for all components showing load and deflection due to load, in enough detail to prove handrail is strong enough and satisfies national, state, local standards, regulations, code requirements, and OSHA 29 CFR 19.10, using design loads specified.
 - c. Include test data for the following:
 - 1) Railing and post connections.
 - 2) Railing wall connections.
 - 3) Post and base connections.
 - 4) Railing expansion joint connections.
4. Manufacturer's Certification of Compliance for specified products.
5. Fabricator's qualification experience.
6. Manufacturer's qualification experience.
7. Independent laboratory test report, dated within 2 years of submittal date, of fire retardant testing conducted on exact type of grating proposed (not a resin test report).

1.04 QUALIFICATIONS

- A. Designer: Calculations required for Contractor design shall be stamped by a registered engineer, licensed in state where Project will be constructed.
- B. Fabricator: Minimum of 5 years' experience.
- C. Manufacturer: Minimum of 5 years' experience in manufacturing of products meeting these specifications.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Preparation for Shipment:
 - 1. Insofar as is practical, factory assemble items provided hereunder.
 - 2. Ladders shall be shipped fully shop-fabricated and assembled.
 - 3. Package and clearly tag parts and assemblies that are of necessity shipped unassembled in a manner that will protect materials from damage, and facilitate identification and final assembly in field.
- B. Storage and Handling: In accordance with manufacturer's recommendations and in such a manner as to prevent damage of any kind, including overexposure to sunlight.

PART 2 PRODUCTS

2.01 GENERAL

- A. Like Items of Materials: Where possible, provide end products of one manufacturer in order to achieve standardization for appearance, maintenance, and replacement.
- B. Unless otherwise specified, all products shall be manufactured by a pultruded process using vinyl ester resin.
- C. Products shall be manufactured with ultra-violet (UV) inhibitor additives.
- D. Exterior surfaces shall have a synthetic surface veil covering.
- E. Furnish molded products as an option where permitted by specifications.
- F. Fire Retardance:
 - 1. Flame spread shall be less than 25 as measured by ASTM E84.
 - 2. Include combinations of aluminum trihydrate, halogen, and antimony trioxide, where required to meet fire retardance, in the resin system.
 - 3. Meet self-extinguishing requirements of ASTM D635.

- G. Color pigment shall be dispersed in resin system.
- H. Fabricate FRP products exposed to outdoor conditions with an additional 1-mil thick UV coating to shield product from UV light.
- I. All cut ends, holes, and abrasions of FRP shapes shall be sealed with resin to prevent intrusion of moisture.

2.02 GRATING AND STAIR TREADS

A. General:

- 1. 100 psf minimum, unless otherwise shown.
- 2. Maximum Deflection: 1/4 inch, unless otherwise shown.
- 3. Stair Tread: 100 psf uniform load or concentrated load of 300 pounds on area of 4 square inches located in center of tread, whichever produces greater stress.

B. Molded Type:

- 1. Nonskid grit affixed to top of bar surface or a concave, meniscus top to all bars, providing skid resistance.
- 2. Load bars in both directions with equal stiffness.
- 3. Square mesh with 1-1/2-inch maximum spacing.

C. Hold-Down Clamps: Type 316 stainless steel.

D. Bolts and Connectors:

- 1. Corrosion-resistant FRP or Type 316 stainless steel.
- 2. Size and strength to meet UBC requirements.

E. Fabrications:

- 1. Field measure areas to receive grating. Verify dimensions of new fabricated supports, and fabricate to dimension required for specified clearances.
- 2. Section Length: Sufficient to prevent it falling through clear opening when oriented in span direction when one end is touching either concrete or vertical leg of grating support.

F. Manufacturers:

- 1. Fibergrate Composite Structures, Inc., Addison, TX.
- 2. IKG/Borden, Clark, NJ.
- 3. Strongwell Corp., Bristol Division, Bristol, VA or Chatfield Division, Chatfield, MN.
- 4. International Grating, Inc., Houston, TX.

2.03 STRUCTURAL PLATFORMS

A. Deflection and Safety Factors:

1. Deflection Criteria: Not to exceed $L/360$.
2. Safety Factors: Minimum ratios of ultimate stress to allowable static service stress:
 - a. Flexural Members: 2.5.
 - b. Compression Members: 3.0.
 - c. Shear: 3.0.
 - d. Connections: 4.0.
3. Minimum design safety factors for dynamic or impact loads shall be twice the values for static service loads.

B. Loads:

1. 100 psf uniform live load over platform.
2. Static and dynamic loads for equipment shown.

C. Glass fiber reinforced polyester or vinyl ester resin matrix, approximately 50 percent resin-to-glass ratio.

D. Continuous glass strand rovings shall be used internally for longitudinal strength.

E. Continuous strand glass mats shall be used internally for transverse strength.

F. Material Properties:

Minimum Ultimate Coupon Properties (UN)		
Material Properties	Test Method	Units
Pultruded Fiberglass Structural Shapes		
Ultimate tensile stress in longitudinal direction, psi (MPa)	ASTM D638	30,000 (207)
Ultimate compressive stress in longitudinal direction, psi (MPa)	ASTM D695	30,000 (207)
Ultimate flexural stress in longitudinal direction, psi (MPa)	ASTM D790	30,000 (207)

Minimum Ultimate Coupon Properties (UN)		
Material Properties	Test Method	Units
Ultimate short beam shear in longitudinal direction, psi (MPa)	ASTM D2344	4,500 (31)
Ultimate tensile stress in transverse direction, psi (MPa)	ASTM D638	7,000 (48)
Ultimate compressive stress in transverse direction, psi (MPa)	ASTM D695	15,000 (103)
Ultimate flexural stress in transverse direction, psi (MPa)	ASTM D790	10,000 (69)
Density (lb/in. ³) (kg/mm ³)	ASTM D792	0.060-0.070 (0.00166-0.0194)
Water absorption (25-hr immersion)	ASTM D570	0.60 max, % by weight
Barcol hardness	ASTM D2583	45
Coefficient of thermal expansion 10 ⁻⁶ in./in./° C	ASTM D696	
Expansion, LW10 ⁻⁶ in./in./° F		4.4
Thermal conductivity, Btu-in./ft ² /hr/° F	ASTM C177	
Flame-Retardant Properties		
Flammability test	ASTM D635	Self-extinguishing
Surface burning characteristics	ASTM E84	25 maximum
Flammability class	UL 94	VO
Temperature index	UL 94	130 C

G. Manufacturers and Designers:

1. Strongwell Corp., Bristol, VA.
2. Fibergrate Composite Structures, Inc., Addison, TX.

2.04 LADDERS AND CAGES

A. Ladder Criteria:

1. Capable of supporting a 250-pound concentrated load plus 30 percent impact at midspan of rung.
2. Side Rails: 1-3/4-inch square tubes, 0.25 inch thick.
3. Rungs: Minimum 1-inch diameter thermal cure rod with pigmented epoxy, nonskid grit surface, or 1-1/4-inch minimum diameter pultruded, fluted, nonslip surface of vinyl ester resin.

B. Cage Criteria:

1. Capable of withstanding a 200-pound load in any direction at any location without permanent distortion.
2. Top and Bottom Hoops: 3-inch minimum width by 1/4-inch minimum thickness.
3. Intermediate Hoops: 2-inch minimum width by 1/4-inch minimum thickness.
4. Hoops manufactured by open-mold hand layup process.
5. Vertical Connecting Straps to Hoops:
 - a. 2-inch-wide by 3/16-inch-thick or 2-inch-wide by 9/16-inch pultruded channels.
 - b. Maximum Spacing: 9 inches.
6. Maximum Vertical Distance Between Hoops: 3 feet 6 inches.

C. Manufacturers:

1. Strongwell Corp., Bristol, VA.
2. Fibergrate Composite Structures, Inc., Addison, TX.

PART 3 EXECUTION

3.01 GENERAL

- A. Install in accordance with manufacturer's written instructions.
- B. Install plumb or level, rigid and neat, as applicable.
- C. Furnish fasteners and anchorages for complete installation.
- D. Seal field cut holes, edges, and abrasions with catalyzed resin compatible with original resin.

3.02 GRATING

- A. Anchor grating securely to supports to prevent displacement.
- B. Install each grating section such that it is easily removable.
- C. Clearance (Grating to Vertical Surfaces): 1/4 inch (plus or minus 1/8-inch tolerance).

3.03 STRUCTURAL SHAPES

- A. Connect parts with approved connectors meeting manufacturer's design requirements and with corrosion resistance equal to structural shapes.
- B. Provide supports and bracings required to comply with applicable codes and design requirements.

3.04 LADDERS AND CAGES

- A. Epoxy and rivet joints and rungs.
- B. Attach hoops to maintain full width clearance between rails, full height of ladder.

END OF SECTION

SECTION 07 92 01 SEALANTS AND CAULKING

PART 1 GENERAL

1.01 REFERENCES

- A. The following is a list of standards that may be referenced in this section:
 - 1. ASTM International (ASTM):
 - a. C920, Standard Specification for Elastomeric Joint Sealants.
 - b. C962, Standard Guide for Use of Elastomeric Joint Sealants.

1.02 ENVIRONMENTAL REQUIREMENTS

- A. Ambient Temperature: Between 40 degrees F and 80 degrees F when sealant is applied. Consult manufacturer when sealant cannot be applied within these temperature ranges.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Sealant Type 4: Multipart polyurethane; ASTM C920, Type M, Grade NS, Class 25; Sonolastic NP-II, Pecora Dynatrol II, or Tremco Dymeric.
- B. Sealant Type 6: One-part polyurethane; ASTM C920, Type S, Grade NS, Class 25; Sonolastic NP-I, Pecora Dynatrol I, or Tremco Dymonic.
- C. Sealant Type 9: One-part acrylic; Tremco Mono, Pecora 60+ Unicrylic, or PTI 738.
- D. Sealant Type 11: Dow Corning Corp., Fire Stop Sealant or Foam; 3M Corp., Fire Barrier Caulk CP25 and Putty 303; General Electric, Pensil Sealant or Foam.
- E. Backup Rod: Nongassing, extruded, closed-cell, round polyethylene foam rod.

PART 3 EXECUTION

3.01 PREPARATION

- A. Verify conditions are acceptable for sealants; clean, dry, sound, and free of dust and other foreign matter.
- B. Mask adjacent surfaces.

3.02 INSTALLATION

- A. Conform to ASTM C962.
- B. Backup Rod: Install in joints wider than 3/16 inch.
- C. Seal joints around windows, doors, and louver frames, and as indicated.
- D. Apply materials in accordance with manufacturer's recommendations and instructions.
- E. Fill joints completely from back to face, without voids.
- F. Tool joints concave.

3.03 CLEANING

- A. Clean smears and other soiling caused by sealant.
- B. Replace or repair to Owner's satisfaction damaged surfaces resulting from sealing or cleaning.

3.04 APPLICATION SCHEDULE

- A. Type 4 or 6: Exterior joints.
- B. Type 9: Interior joints.
- C. Type 11: Holes and voids around penetrations through fire rated elements.

END OF SECTION

SECTION 09 90 00 PAINTING AND COATING

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American Water Works Association (AWWA):
 - a. C203, Coal-Tar Protective Coatings and Linings for Steel Water Pipelines—Enamel and Tape—Hot-Applied.
 - b. C209, Cold-Applied Tape Coatings for the Exterior of Special Sections, Connections, and Fittings for Steel Water Pipelines.
 - c. C213, Fusion-Bonded Epoxy Coating for the Interior and Exterior of Steel Water Pipelines.
 - d. C214, Tape Coating Systems for the Exterior of Steel Water Pipelines.
2. Environmental Protection Agency (EPA).
3. NACE International (NACE): SP0188, Discontinuity (Holiday) Testing of New Protective Coatings on Conductive Substrates.
4. NSF International (NSF): 61, Drinking Water System Components - Health Effects.
5. Occupational Safety and Health Act (OSHA).
6. Research Council on Structural Connections (RCSC): Specification for Structural Joints using High-Strength Bolts.
7. The Society for Protective Coatings (SSPC):
 - a. PA 2, Procedure for Determining Conformance to Dry Coating Thickness Requirements.
 - b. PA 10, Guide to Safety and Health Requirements for Industrial Painting Projects.
 - c. SP 1, Solvent Cleaning.
 - d. SP 2, Hand Tool Cleaning.
 - e. SP 3, Power Tool Cleaning.
 - f. SP 5, White Metal Blast Cleaning.
 - g. SP 6, Commercial Blast Cleaning.
 - h. SP 7, Joint Surface Preparation Standard Brush-Off Blast Cleaning.
 - i. SP 10, Near-White Blast Cleaning.
 - j. SP 11, Power Tool Cleaning to Bare Metal.
 - k. SP 16, Brush-Off Blast Cleaning of Coated and Uncoated Galvanized Steel, Stainless Steels, and Non-Ferrous Metals.
 - l. SP 13, Surface Preparation of Concrete.
 - m. Guide 15, Field Methods for Retrieval and Analysis of Soluble Salts on Steel and Other Nonporous Substrates.

1.02 DEFINITIONS

A. Terms used in this section:

1. Coverage: Total minimum dry film thickness in mils or square feet per gallon.
2. FRP: Fiberglass Reinforced Plastic.
3. MDFT: Minimum Dry Film Thickness, mils.
4. MDFTPC: Minimum Dry Film Thickness per Coat, mils.
5. Mil: Thousandth of an inch.
6. PDS: Product Data Sheet.
7. PSDS: Paint System Data Sheet.
8. PVC: Polyvinyl Chloride.
9. SFPG: Square Feet per Gallon.
10. SFPGPC: Square Feet per Gallon per Coat.
11. SP: Surface Preparation.

1.03 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
 - a. Data Sheets:
 - 1) For each product, furnish a Product Data Sheet (PDS), the manufacturer's technical data sheets, and paint colors available (where applicable). The PDS form is appended to the end of this section.
 - 2) For each paint system, furnish a Paint System Data Sheet (PSDS). The PSDS form is appended to the end of this section.
 - 3) Technical and performance information that demonstrates compliance with specification.
 - 4) Furnish copies of paint system submittals to the coating applicator.
 - 5) Indiscriminate submittal of only manufacturer's literature is not acceptable.
 - b. Detailed chemical and gradation analysis for each proposed abrasive material.

B. Informational Submittals:

1. Coating manufacturer's Certificate of Compliance, in accordance with Section 01 43 33, Manufacturers' Field Services.
2. Factory Applied Coatings: Manufacturer's certification stating factory applied coating system meets or exceeds requirements specified.
3. Manufacturer's written verification that submitted material is suitable for the intended use.

4. Coating for Faying Surfaces: Manufacturer's test results that show the proposed coating meets the slip resistance requirements of the AISC Specification for Structural Joints using ASTM A325 or ASTM A490 bolts.
5. If the manufacturer of finish coating differs from that of shop primer, provide finish coating manufacturer's written confirmation that materials are compatible.
6. Manufacturer's written instructions and special details for applying each type of paint.

1.04 QUALITY ASSURANCE

- A. Applicator Qualifications: Minimum 5 years' experience in application of specified products.
- B. Regulatory Requirements:
 1. Meet federal, state, and local requirements limiting the emission of volatile organic compounds.
 2. Perform surface preparation and painting in accordance with recommendations of the following:
 - a. Paint manufacturer's instructions.
 - b. SSPC PA 10.
 - c. Federal, state, and local agencies having jurisdiction.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Shipping:
 1. Where precoated items are to be shipped to the Site, protect coating from damage. Batten coated items to prevent abrasion.
 2. Protect shop painted surfaces during shipment and handling by suitable provisions including padding, blocking, and use of canvas or nylon slings.
- B. Storage:
 1. Store products in a protected area that is heated or cooled to maintain temperatures within the range recommended by paint manufacturer.
 2. Primed surfaces shall not be exposed to weather for more than 2 months before being topcoated, or less time if recommended by coating manufacturer.

1.06 PROJECT CONDITIONS

A. Environmental Requirements:

1. Do not apply paint in temperatures or moisture conditions outside of manufacturer's recommended maximum or minimum allowable.
2. Do not perform final abrasive blast cleaning whenever relative humidity exceeds 85 percent, or whenever surface temperature is less than 5 degrees F above dew point of ambient air.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Nationally recognized manufacturers of paints and protective coatings who are regularly engaged in the production of such materials for essentially identical service conditions.
- B. Minimum of 5 years' verifiable experience in manufacture of specified product.
- C. Each of the following manufacturers is capable of supplying most of the products specified herein:
 1. Carboline.
 2. Tnemec.
 3. Sherwin Williams.

2.02 ABRASIVE MATERIALS

- A. Select abrasive type and size to produce surface profile that meets coating manufacturer's recommendations for specific primer and coating system to be applied.

2.03 PAINT MATERIALS

- A. General:
 1. Manufacturer's highest quality products suitable for intended service.
 2. Compatibility: Only compatible materials from a single manufacturer shall be used in the Work. Particular attention shall be directed to compatibility of primers and finish coats.
 3. Thinners, Cleaners, Driers, and Other Additives: As recommended by coating manufacturer.

B. Products:

Product	Definition
Acrylic Latex	Single-component, finish as required
Acrylic Latex (Flat)	Flat latex
Acrylic Sealer	Clear acrylic
Bituminous Paint	Single-component, coal-tar pitch based
Coal-Tar Epoxy	Amine, polyamide, or phenolic epoxy type 70% volume solids minimum, suitable for immersion service
Epoxy Primer— Ferrous Metal	Anticorrosive, converted epoxy primer containing rust-inhibitive pigments
Fusion Bonded Coating	100% solids, thermosetting, fusion bonded, dry powder epoxy, suitable for the intended service
High Build Epoxy	Polyamidoamine epoxy, minimum 69% volume solids, capability of 4 to 8 MDFT per coat
Polyurethane Enamel	Two-component, aliphatic or acrylic based polyurethane; high gloss finish

2.04 MIXING

A. Multiple-Component Coatings:

1. Prepare using each component as packaged by paint manufacturer.
2. No partial batches will be permitted.
3. Do not use multiple-component coatings that have been mixed beyond their pot life.
4. Furnish small quantity kits for touchup painting and for painting other small areas.
5. Mix only components specified and furnished by paint manufacturer.
6. Do not intermix additional components for reasons of color or otherwise, even within the same generic type of coating.

B. Colors: Formulate paints with colorants free of lead, lead compounds, or other materials that might be affected by presence of hydrogen sulfide or other gas likely to be present at Site.

2.05 SHOP FINISHES

- A. Shop Blast Cleaning: Reference Paragraph, Shop Coating Requirements.
- B. Shop Coating Requirements:
 - 1. When required by equipment specifications, such equipment shall be primed and finish coated in shop by manufacturer and touched up in field with identical material after installation.
 - 2. Where manufacturer's standard coating is not suitable for intended service condition, Engineer may approve use of a tie-coat to be used between manufacturer's standard coating and specified field finish. In such cases, tie-coat shall be surface tolerant epoxy as recommended by manufacturer of specified field finish coat. Coordinate details of equipment manufacturer's standard coating with field coating manufacturer.

PART 3 EXECUTION

3.01 GENERAL

- A. Provide Engineer minimum 7 days' advance notice to start of field surface preparation work and coating application work.
- B. Perform the Work only in presence of Engineer, unless Engineer grants prior approval to perform the Work in Engineer's absence.
- C. Schedule inspection of cleaned surfaces and all coats prior to succeeding coat in advance with Engineer.

3.02 EXAMINATION

- A. Factory Finished Items:
 - 1. Schedule inspection with Engineer before repairing damaged factory-finished items delivered to Site.
 - 2. Repair abraded or otherwise damaged areas on factory-finished items as recommended by coating manufacturer. Carefully blend repaired areas into original finish. If required to match colors, provide full finish coat in field.
- B. Surface Preparation Verification: Inspect and provide substrate surfaces prepared in accordance with these Specifications and printed directions and recommendations of paint manufacturer whose product is to be applied. The more stringent requirements shall apply.

3.03 PROTECTION OF ITEMS NOT TO BE PAINTED

- A. Remove, mask, or otherwise protect hardware, lighting fixtures, switchplates, aluminum surfaces, machined surfaces, couplings, shafts, bearings, nameplates on machinery, and other surfaces not specified elsewhere to be painted.
- B. Provide drop cloths to prevent paint materials from falling on or marring adjacent surfaces.
- C. Protect working parts of mechanical and electrical equipment from damage during surface preparation and painting process.
- D. Mask openings in motors to prevent paint and other materials from entering.
- E. Protect surfaces adjacent to or downwind of Work area from overspray.

3.04 SURFACE PREPARATION

- A. Field Abrasive Blasting:
 - 1. Perform blasting for items and equipment where specified and as required to restore damaged surfaces previously shop or field blasted and primed or coated.
 - 2. Refer to coating systems for degree of abrasive blasting required.
 - 3. Where the specified degree of surface preparation differs from manufacturer's recommendations, the more stringent shall apply.
- B. Metal Surface Preparation:
 - 1. Where indicated, meet requirements of SSPC Specifications summarized below:
 - a. SP 1, Solvent Cleaning: Removal of visible oil, grease, soil, drawing and cutting compounds, and other soluble contaminants by cleaning with solvent.
 - b. SP 2, Hand Tool Cleaning: Removal of loose rust, loose mill scale, loose paint, and other loose detrimental foreign matter, using nonpower hand tools.
 - c. SP 3, Power Tool Cleaning: Removal of loose rust, loose mill scale, loose paint, and other loose detrimental foreign matter, using power-assisted hand tools.
 - 2. The words "solvent cleaning", "hand tool cleaning", "wire brushing", and "blast cleaning", or similar words of equal intent in these Specifications or in paint manufacturer's specification refer to the applicable SSPC Specification.
 - 3. Where OSHA or EPA regulations preclude standard abrasive blast cleaning, wet or vacu-blast methods may be required. Coating manufacturers' recommendations for wet blast additives and first coat application shall apply.

4. Hand tool clean areas that cannot be cleaned by power tool cleaning.
5. Round or chamfer sharp edges and grind smooth burrs, jagged edges, and surface defects.
6. Preblast Cleaning Requirements:
 - a. Remove oil, grease, welding fluxes, and other surface contaminants prior to blast cleaning.
 - b. Cleaning Methods: Steam, open flame, hot water, or cold water with appropriate detergent additives followed with clean water rinsing.
 - c. Clean small isolated areas as above or solvent clean with suitable solvent and clean cloth.
7. Blast Cleaning Requirements:
 - a. Type of Equipment and Speed of Travel: Design to obtain specified degree of cleanliness. Minimum surface preparation is as specified herein and takes precedence over coating manufacturer's recommendations.
 - b. Select type and size of abrasive to produce surface profile that meets coating manufacturer's recommendations for particular primer to be used.
 - c. Use only dry blast cleaning methods.
 - d. Do not reuse abrasive, except for designed recyclable systems.
 - e. Meet applicable federal, state, and local air pollution and environmental control regulations for blast cleaning, confined space entry (if required), and disposition of spent aggregate and debris.
8. Post-Blast Cleaning and Other Cleaning Requirements:
 - a. Clean surfaces of dust and residual particles from cleaning operations by dry (no oil or water vapor) air blast cleaning or other method prior to painting. Vacuum clean enclosed areas and other areas where dust settling is a problem and wipe with a tack cloth.
 - b. Paint surfaces the same day they are blasted. Reblast surfaces that have started to rust before they are painted.

C. Concrete Surface Preparation:

1. Do not begin until 30 days after concrete has been placed.
2. Meet requirements of SSPC SP 13.
3. Remove grease, oil, dirt, salts or other chemicals, loose materials, or other foreign matter by solvent, detergent, or other suitable cleaning methods.
4. Brush-off blast clean to remove loose concrete and laitance, and provide a tooth for binding. Upon approval by Engineer, surface may be cleaned by acid etching method. Approval is subject to producing desired profile equivalent to No. 80 grit flint sandpaper. Acid etching of vertical or overhead surfaces shall not be allowed.

5. Secure coating manufacturer's recommendations for additional preparation, if required, for excessive bug holes exposed after blasting.
 6. Unless otherwise required for proper adhesion, ensure surfaces are dry prior to painting.
- D. PVC and CPVC Surface Preparation: Hand sand plastic surfaces to be coated with medium grit sandpaper to provide tooth for coating system.
- E. Existing Painted Surfaces to be Repainted Surface Preparation:
1. Detergent wash and freshwater rinse.
 2. Clean loose, abraded, or damaged coatings to substrate by hand or power tool, SP 2 or SP 3.
 3. Feather surrounding intact coating.
 4. Apply one spot coat of specified primer to bare areas, overlapping prepared existing coating.
 5. Apply one full finish coat of specified primer to entire surface.
 6. If an aged, plural-component material is to be topcoated, contact coating manufacturer for additional surface preparation requirements.
 7. Application of Cosmetic Coat:
 - a. It is assumed that existing coatings have oxidized sufficiently to prevent lifting or peeling when overcoated with paints specified.
 - b. Check compatibility by application to a small area prior to starting painting.
 - c. If lifting or other problems occur, request disposition from Engineer.
 8. Perform blasting as required to restore damaged surfaces. Materials, equipment, procedures shall meet requirements of SSPC.

3.05 SURFACE CLEANING

A. Solvent Cleaning:

1. Consists of removal of foreign matter such as oil, grease, soil, drawing and cutting compounds, and any other surface contaminants by using solvents, emulsions, cleaning compounds, steam cleaning, or similar materials and methods that involve a solvent or cleaning action.
2. Meet requirements of SSPC SP 1.

3.06 APPLICATION

A. General:

1. The intention of these Specifications is for existing and new, interior and exterior concrete, and piping surfaces to be painted, whether specifically mentioned or not, except as specified otherwise.

2. Apply coatings in accordance with these Specifications and paint manufacturers' printed recommendations and special details. The more stringent requirements shall apply. Allow sufficient time between coats to assure thorough drying of previously applied paint.
3. Vacuum clean surfaces free of loose particles. Use tack cloth just prior to applying next coat.
4. On pipelines, terminate coatings along pipe runs to 1 inch inside pipe penetrations.
5. Keep paint materials sealed when not in use.
6. Where more than one coat is applied within a given system, alternate colors to provide a visual reference showing required number of coats have been applied.

B. Porous Surfaces, Such as Concrete:

1. Filler/Surfacer: Use coating manufacturer's recommended product to fill air holes, bug holes, and other surface voids or defects.
2. Prime Coat: May be thinned to provide maximum penetration and adhesion.
 - a. Type and Amount of Thinning: Determined by paint manufacturer and dependent on surface density and type of coating.
3. Surface Specified to Receive Water Base Coating: Damp, but free of running water, just prior to application of coating.

C. Film Thickness and Coverage:

1. Number of Coats:
 - a. Minimum required without regard to coating thickness.
 - b. Additional coats may be required to obtain minimum required paint thickness, depending on method of application, differences in manufacturers' products, and atmospheric conditions.
2. Application Thickness:
 - a. Do not exceed coating manufacturer's recommendations.
 - b. Measure using a wet film thickness gauge to ensure proper coating thickness during application.
3. Film Thickness Measurements and Electrical Inspection of Coated Surfaces:
 - a. Perform with properly calibrated instruments.
 - b. Recoat and repair as necessary for compliance with specification.
 - c. Coats are subject to inspection by Engineer and coating manufacturer's representative.
4. Visually inspect concrete, masonry, nonferrous metal, plastic, and wood surfaces to ensure proper and complete coverage has been attained.
5. Give particular attention to edges, angles, flanges, and other similar areas, where insufficient film thicknesses are likely to be present, and ensure proper millage in these areas.

6. Apply additional coats as required to achieve complete hiding of underlying coats. Hiding shall be so complete that additional coats would not increase the hiding.

3.07 PROTECTIVE COATINGS SYSTEMS AND APPLICATION SCHEDULE

- A. Unless otherwise shown or specified, paint surfaces in accordance with the following application schedule. In the event of discrepancies or omissions in the following, request clarification from Engineer before starting work in question.
- B. System No. 4 Exposed Metal—Highly Corrosive:

Surface Prep.	Paint Material	Min. Coats, Cover
SP 10, Near-White Blast Cleaning	Epoxy Primer— Ferrous Metal	1 coat, 2.5 MDFT
	High Build Epoxy	1 coat, 4 MDFT
	Polyurethane Enamel	1 coat, 3 MDFT

1. Use on the following items or areas:
 - a. Exposed metal surfaces, new located inside or outside of structures and exposed to weather, and the following specific surfaces:
 - 1) Exposed non-stainless steel metal surfaces in the chlorine dioxide chemical containment area.

- C. System No. 6 Exposed Metal—Atmospheric:

Surface Prep.	Paint Material	Min. Coats, Cover
SP 6, Commercial Blast Cleaning	Rust-Inhibitive Primer	1 coat, 2 MDFT
	Alkyd Enamel	2 coats, 4 MDFT

1. Use on the following items or areas:
 - a. Exposed non-stainless metal surfaces, new and located inside or outside of structures or exposed to weather, including metal doors and frames, vents, louvers, exterior metal ductwork, flashing, sheet metalwork and miscellaneous architectural metal trim, and the following specific surfaces.
 - 1) Inside duct stack heads behind diffusers, registers, and grilles with flat black.
 - 2) Instrumentation and control systems exposed enclosures for process.

- b. Apply surface preparation and primer to surfaces prior to installation. Finish coats need only be applied to surfaces exposed after completion of construction.

D. System No. 7 Concrete Encased Metal:

Surface Prep.	Paint Material	Min. Coats, Cover
SP 6, Commercial Blast Cleaning	Coal-Tar Epoxy	2 coats, 16 MDFT

1. Use on the following items or areas: Use on concrete encased ferrous metals including wall pipes, pipe sleeves, and access manholes.

E. System No. 22 Chemical-Resistant Wall, Heavy-Duty—Concrete:

Surface Prep.	Paint Material	Min. Coats, Cover
In accordance with Paragraph Concrete Surface Preparation	Epoxy Filler/Surfacer	1 coat as required to fill voids and smooth surface; apply to 100 percent of surface.
	High Build Epoxy	1 coat, 160 SFPG
	High Build Epoxy, Gloss	1 coat, 160 SFPG

1. Use on the following items or areas: Outside chemical containment wall surfaces. See Specification 09 96 35, Chemical-Resistant Coatings for top and interior wall surfaces and floor of containment structure.

F. System No. 25 Exposed PVC and CPVC:

Surface Prep.	Paint Material	Min. Coats, Cover
In accordance with Paragraph Plastic and FRP Surface Preparation	Acrylic Latex Flat	2 coats, 320 SFPGPC

1. Use on the following items or areas: All exposed-to-view PVC and CPVC surfaces.

G. System No. 27 Aluminum and Dissimilar Metal Insulation:

Surface Prep.	Paint Material	Min. Coats, Cover
Solvent Clean (SP 1)	Prime in accordance with manufacturer's recommendations	
	Bituminous Paint	1 coat, 10 MDFT

1. Use on aluminum surfaces embedded or in contact with concrete.

H. System No. 28 Existing Painted Masonry, Semigloss:

Surface Prep.	Paint Material	Min. Coats, Cover
In accordance with Paragraph Existing Painted Surfaces to be Repainted Surface Preparation	Acrylic Latex (Semigloss)	2 coats, 240 SFPGPC

1. Use on the following items or areas: All wall surfaces above 6 feet AFF in existing reconfigured Chemical Building Chlorine Dioxide Generation Room after all demolition and patchwork has been completed and before new Chlorine Dioxide System is installed. (Note: Chemical resistant coating CRC-1 is to be applied to floor and walls up to a height of 6 feet AFF.)

3.08 COLORS

- A. Provide as shown in Piping Schedule and as selected by Owner.
- B. Proprietary identification of colors is for identification only. Selected manufacturer may supply matches.
- C. Equipment Colors: Equipment includes the machinery or vessel itself plus the structural supports and fasteners and attached electrical conduits.
- D. Pipe Identification Painting:
 1. Color code nonsubmerged metal piping, except electrical conduit. Paint fittings and valves the same color as pipe, except equipment isolation valves.
 2. Pipe Color Coding: In accordance with Piping Schedule.
 3. Pipe Supports: Painted light gray, as approved by Engineer.

3.09 FIELD QUALITY CONTROL

A. Testing Equipment:

1. Provide calibrated electronic type dry film thickness gauge to test coating thickness specified in mils.
2. Provide low-voltage wet sponge electrical holiday detector to test completed coating systems, 20 mils dry film thickness or less, except zinc primer, high-build elastomeric coatings, and galvanizing, for pinholes, holidays, and discontinuities, as manufactured by Tinker and Rasor, San Gabriel, CA, Model M-1.
3. Provide high-voltage spark tester to test completed coating systems in excess of 20 mils dry film thickness. Unit as recommended by coating manufacturer.

B. Testing:

1. Thickness and Continuity Testing:
 - a. Measure coating thickness specified in mils with a magnetic type, dry film thickness gauge, in accordance with SSPC PA 2. Check each coat for correct millage. Do not make measurement before a minimum of 8 hours after application of coating.
 - b. Holiday detect coatings 20 mils thick or less, except zinc primer and galvanizing, with low voltage wet sponge electrical holiday detector in accordance with NACE SP0188.
 - c. Holiday detect coatings in excess of 20 mils dry with high voltage spark tester as recommended by coating manufacturer and in accordance with NACE SP0188.
 - d. After repaired and recoated areas have dried sufficiently, retest each repaired area. Final tests may also be conducted by Engineer.

C. Inspection: Leave staging and lighting in place until Engineer has inspected surface or coating. Replace staging removed prior to approval by Engineer. Provide additional staging and lighting as requested by Engineer.

D. Unsatisfactory Application:

1. If item has an improper finish color or insufficient film thickness, clean surface and topcoat with specified paint material to obtain specified color and coverage. Obtain specific surface preparation information from coating manufacturer.
2. Evidence of runs, bridges, shiners, laps, or other imperfections is cause for rejection.
3. Repair defects in accordance with written recommendations of coating manufacturer.

E. Damaged Coatings, Pinholes, and Holidays:

1. Hand or power sand visible areas of chipped, peeled, or abraded paint, and feather edges. Follow with primer and finish coat. Depending on extent of repair and appearance, a finish sanding and topcoat may be required.
2. Remove rust and contaminants from metal surface. Provide surface cleanliness and profile in accordance with surface preparation requirements for specified paint system.
3. Feather edges and repair in accordance with recommendations of paint manufacturer.
4. Apply finish coats, including touchup and damage-repair coats in a manner that will present a uniform texture and color-matched appearance.

3.10 CLEANUP

- A. Place cloths and waste that might constitute a fire hazard in closed metal containers or destroy at end of each day.
- B. Upon completion of the Work, remove staging, scaffolding, and containers from Site or destroy in a legal manner.
- C. Remove paint spots, oil, or stains upon adjacent surfaces and floors and leave entire job clean.

3.11 SUPPLEMENTS

- A. The supplements listed below, following “End of Section,” are a part of this Specification:
 1. Paint System Data Sheet (PSDS).
 2. Product Data Sheet (PDS).

END OF SECTION

PAINT SYSTEM DATA SHEET (PSDS)

Complete this PSDS for each coating system, include all components of the system (surface preparation, primer, intermediate coats, and finish coats). Include all components of a given coating system on a single PSDS.

Paint System Number (from Spec.):		
Paint System Title (from Spec.):		
Coating Supplier:		
Representative:		
Surface Preparation:		
Paint Material (Generic)	Product Name/Number (Proprietary)	Min. Coats, Coverage

PAINT PRODUCT DATA SHEET (PPDS)

Complete and attach manufacturer's Technical Data Sheet to this PDS for each product submitted. Provide manufacturer's recommendations for the following parameters at temperature (F)/relative humidity:

Temperature/RH	50/50	70/30	90/25
Induction Time			
Pot Life			
Shelf Life			
Drying Time			
Curing Time			
Min. Recoat Time			
Max. Recoat Time			

Provide manufacturer's recommendations for the following:

Mixing Ratio: .

Maximum Permissible Thinning: _____

Ambient Temperature Limitations: min.: max.: _____

Surface Temperature Limitations: min.: max.: _____

Surface Profile Requirements: min.: max.: _____

Attach additional sheets detailing manufacturer's recommended storage requirements and holiday testing procedures.

SECTION 09 96 35
CHEMICAL-RESISTANT COATINGS

PART 1 GENERAL

1.01 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
 - a. List materials in proposed system.
 - b. Manufacturer's product specification.
 - c. Chemical resistance test results for exposure to service conditions.
 - d. Application instructions.
 - e. Configuration details of materials at terminations, construction joints, floor drains, and trenches.

B. Informational Submittals:

1. Letter from manufacturer stating applicator is qualified to do the Work and meets the quality assurance minimum experience requirements.
2. Sample of warranty, prior to starting the Work.
3. Installation instructions.
4. Field inspection and test reports.
5. Manufacturer's Certificate of Proper Installation, in accordance with Section 01 43 33, Manufacturers' Field Services.
6. Special guarantee.

1.02 QUALITY ASSURANCE

A. Manufacturer's Experience: Minimum 5 years manufacturing proposed products.

B. Applicator's Experience: Minimum 3 years applying proposed products.

1.03 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials in manufacturer's original, unopened containers.

B. Storage: Maintain materials in clean and dry condition. Follow manufacturer's instructions.

1.04 ENVIRONMENTAL REQUIREMENTS

A. Temperature: Apply coating only when substrate, ambient air, and coating material are 65 degrees F or above.

- B. Substrate: Not wet or have standing water.
- C. Ventilation: Provide during and after application to meet all applicable safety and health regulations.

1.05 EXTRA MATERIALS

- A. Furnish minimum 2 gallons of unopened topcoating material for future use by Owner.

1.06 SPECIAL GUARANTEE

- A. Furnish manufacturer's extended guarantee or warranty, with Owner named as beneficiary, in writing, as special guarantee. Special guarantee shall provide for correction, or at the option of the Owner, removal and replacement of Work specified in this Specification section found defective during a period of one year after the date of Substantial Completion. Duties and obligations for correction or removal and replacement of defective Work as specified in the General Conditions.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Ceilcote Corrosion Control, Brecksville, OH.
- B. Dudick, Inc., Streetsboro, OH.
- C. Stonhard, Maple Shade, NJ.

2.02 SERVICE CONDITIONS

- A. Location:
 - 1. Bulk Chemical Storage Containment: Outdoors, exposed to weather.
 - 2. Chlorine Dioxide Generation Room: Covered, ambient temperature conditions.
- B. Surface:
 - 1. Bulk Chemical Storage Containment: Concrete floors, walls, sumps, and tank pads (including top of pads) for chemical storage and handling.
 - 2. Chlorine Dioxide Generation Room: Concrete floors, equipment pads, and walls to an elevation of six feet above finished floor.
- C. Traffic: Foot, light hand truck, forklifts.

D. Chemicals Stored in Containment Areas:

1. Sulfuric acid, 78 percent solutions.
2. Purate[®] (40 percent sodium chlorate plus <8 percent hydrogen peroxide (stabilizer) in aqueous solution).
3. Chlorine dioxide (aqueous solution).

2.03 COATING SYSTEMS

- A. Chemical-Resistant Coatings: A mixture of liquid resin-based material, setting agent, and filler designed to be troweled into place to cure to a hard state.
- B. Mat-Reinforced Vinyl Ester, System CRC-1: Primer, fiberglass mat, saturant, and two trowel-applied coats of vinyl ester resin with silica fillers. Finished system thickness 150 mils minimum.
- C. System CRC-2: A chemically-resistant, fiberglass-reinforced novolac vinyl ester lining system. Finished system thickness 150 mils minimum.
- D. System CRC-3: A chemically-resistant, fiberglass-reinforced bisphenol F novolac vinyl ester lining system. Finished system thickness 150 mils minimum.

2.04 MIXING

- A. Thoroughly mix until homogeneous following manufacturer's instructions.
- B. Mix only components furnished by coating manufacturer.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Surface Preparation:
 1. Inspect and provide substrate surfaces prepared in accordance with these Specifications and the printed directions and recommendations of the system manufacturer whose product is to be applied.
 2. Provide Engineer minimum 3 days' advance notice of start of surface preparation and system application Work.
 3. Perform Work only in presence of Engineer, unless Engineer grants prior approval to perform Work in Engineer's absence.
- B. Schedule inspection with Engineer in advance for cleaned surfaces and system application Work.

3.02 PREPARATION

- A. In accordance with Section 09 90 00, Painting and Coating, and the manufacturer's printed directions and recommendations.
- B. Fill holes and cracks with manufacturer's recommended materials to produce even surface for application of systems.

3.03 APPLICATION

- A. Install coating systems in accordance with manufacturer's printed instructions.
- B. Install coating systems on vertical and horizontal surfaces, including caps, within containment wall for storage tanks, pumps, and piping.
- C. Extend surfacing completely under structures and equipment located within the containment area. Install at construction joints in substrate and floor drains, trenches, and other components within the containment area.

3.04 FIELD QUALITY CONTROL

- A. Inspection:
 - 1. Inspect finished system for complete, uniform coverage of specified area. Evidence of defects include improper thickness, hardness, and appearance.
 - 2. Engineer may require electrical spark test or other tests to be performed by Contractor when evidence of incomplete coverage exists.

3.05 MANUFACTURER'S SERVICES

- A. Provide manufacturer's representative at Site in accordance with Section 01 43 33, Manufacturers' Field Services, for installation assistance, inspection, and Manufacturer's Certificate of Proper Installation.

3.06 APPLICATION SCHEDULE

- A. Unless otherwise shown or specified, apply coatings in accordance with the following application schedule. In the event of discrepancies or omissions in the following, request clarification from Engineer before starting Work in question.

B. Coating System CRC-1:

1. Use in the following areas: Use in the chlorine dioxide generation room. Apply to all horizontal and vertical surfaces, including all sides and tops of equipment pads and on walls up to an elevation of six feet above finished floor. Coating shall be applied after all holes from removal of existing equipment, piping, conduits, etc., have been patched.

C. Coating System CRC-2:

1. Use in the following areas: Purate bulk storage and containment area, including top and sides of tank pad and top of all exterior containment walls.

D. Coating System CRC-3:

1. Use in the following areas: Sulfuric acid bulk storage and containment area, including the top of all exterior containment walls, top and sides of tank pad, and top of the wall separating the Purate and sulfuric acid containments.
2. Concrete slab/sidewalk at chemical fill stations (approximately 10 feet by 6 feet) to edge of curb/building.

3.07 SUPPLEMENTS

A. The supplement listed below, following “End of Section,” is part of this Specification.

1. Supplement 1, Corrosion Control Assistance Form.

END OF SECTION

CORROSION CONTROL ASSISTANCE FORM

TO: Corrosion Control Specialist. DATE: _____
CH2M HILL

FROM: Name: _____ Title: _____
Address: _____
Project Description: _____
Project No.: _____

Area Requiring Specific Protection: _____

Items to be Coated: _____

Site Location: _____

SERVICE CONDITIONS
(Check Appropriate Items)

Immersion _____ Splash/Spillage _____ Chemical Fumes _____

Marine/Offshore _____ Industrial _____ Other _____

Chemicals Involved _____

New Construction _____ Existing Structure _____ Uncoated _____

Coated _____ Coated With (If Known) _____

Operating Temp. Range _____ Ambient Conditions _____

Surface Preparation Possible: Abrasive Blast _____

Power Tool Cleaning _____ Other _____

Other Pertinent Data: _____

Feedback Required By (Date): _____

SECTION 10 14 00 SIGNAGE

PART 1 GENERAL

1.01 REFERENCES

- A. The following is a list of standards that may be referenced in this section:
1. American Society of Mechanical Engineers (ASME): A13.1, Scheme for the Identification of Piping Systems.
 2. ASTM International (ASTM):
 - a. A53/A53M, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless.
 3. International Code Council (ICC):
 - a. International Fire Code (IFC): Chapter 50, Hazardous Materials-General Provisions.
 4. National Fire Protection Association (NFPA):
 - a. 704, Standard System for the Identification of the Hazards of Materials for Emergency Response.
 - b. HAZ-01, Fire Protection Guide to Hazardous Materials.
 5. Occupational Safety and Health Act (OSHA).

1.02 SUBMITTALS

- A. Action Submittals:
1. Shop Drawings:
 - a. Drawings showing layouts, actual letter sizes and styles, and Project-specific mounting details.
 - b. Manufacturer's literature showing letter sizes and styles, sign materials, and standard mounting details.
- B. Informational Submittals: Manufacturer's installation instructions.

PART 2 PRODUCTS

2.01 DOOR NAMEPLATES (TYPE N)

- A. Material: Plastic with square corners.
- B. Thickness: 1/8 inch.
- C. Height: 2 inches.
- D. Finish: Nondirectional matte.

- E. Background: Black.
- F. Letters: Back-Engraved.
 - 1. Size: 1 inch high.
 - 2. Color: White.
 - 3. Style: Helvetica Regular upper case.
 - 4. Message Text: As shown on Sign Schedule.
 - 5. Braille Text: Domed or rounded as required by ADA regulations, with 3/8-inch minimum clearance on all sides.
- G. Manufacturers and Products:
 - 1. Best Sign Systems; Graphic Blast.
 - 2. Seton, Brady Corporation, Co.

2.02 SIGN TYPES

- A. Plastic Sign (Type A):
 - 1. Exterior: Laminated plastic subsurface image type, 3/16-inch-thick with high-gloss finish.
 - 2. Interior: Plastic, 1/8-inch-thick with nondirectional matte finish and raised letters.
 - 3. Rounded corners.
- B. Die-Cut Adhesive Vinyl (Type D):
 - 1. Material: Material: Adhesive vinyl for curved surfaces.
 - 2. Background, Letters, and Numbers: Die-cut vinyl with pressure sensitive adhesive.
 - 3. Manufacturers:
 - a. ComplianceSigns, Inc.
 - b. Brimar Industries, Inc.
 - c. Seton, Brady Corporation, Co.
- C. Hazardous Material Sign (Type H):
 - 1. Conform to NFPA 704 and NFPA HAZ-01.
 - 2. Material: Adhesive vinyl for curved surfaces.
 - 3. Background, Letters, and Numbers: Die-cut vinyl with pressure sensitive adhesive.
 - 4. Manufacturers:
 - a. ComplianceSigns, Inc.
 - b. Brimar Industries, Inc.

2.03 IDENTIFICATION LABELS

A. Pipe Labels:

1. Snap-on, reversible type with lettering and directional arrows, sized for outside diameter of pipe and insulation.
2. Designed to firmly grip pipe so labels remain fixed in vertical pipe runs.
3. Material: Heavy-duty vinyl or polyester, suitable for exterior use, long lasting, and resistance to moisture, grease, and oils.
4. Letters and Arrows: Black on OSHA safety yellow background.
5. Color Field and Letter Height: Meet ASME A13.1.
6. Message: Piping system name as indicated on Piping Schedule.
7. Manufacturers and Products:
 - a. Brady Worldwide, Inc; B-915 BradySnap-On Pipe Markers.
 - b. Seton, Brady Corporation, Co; Ultra-mark Pipe Markers.

B. Equipment Labels:

1. Applies to equipment with assigned tag numbers, where specified.
2. Letters: Black bold face, 3/4 inch minimum high.
3. Background: OSHA safety yellow.
4. Materials: Multi-layered acrylic or other plastic intended for indoor or outdoor use and fade resistant.
5. Furnish 1-inch margin with holes at each end of label, for mounting.
6. Size:
 - a. 1 inch minimum and 1-1/2 inches maximum high, by 3 inches minimum and 4 inches maximum long.
 - b. Furnish same size base dimensions for all labels.
7. Message: Equipment names and tag numbers as used in sections where equipment is specified.
8. Manufacturers:
 - a. Marking Services, Inc. (MSI).
 - b. Seton, Brady Corporation, Co.

2.04 ANCILLARY MATERIALS

- A. Fasteners: Stainless steel screws or bolts of appropriate sizes.
- B. Pipe Posts: 2-1/2-inch galvanized steel pipe meeting ASTM A53/A53M, Type S, Grade B.
- C. Chain: Type 304 stainless steel, No. 16 single jack chain or No. 2 double loop coil chain.

PART 3 EXECUTION**3.01 INSTALLATION—GENERAL**

- A. In accordance with manufacturer's recommendations.
- B. Mount securely, plumb, and level.

3.02 DOOR NAMEPLATES

- A. Attach to doors or walls adjacent to doors with self-sticking removable adhesive. See Sign Schedule for locations and messages.
- B. Mount with bottom of nameplate at 5 feet 6 inches above floor.

3.03 SIGNS

- A. General:
 - 1. Fasten to walls or posts, or hang as scheduled.
 - 2. Anchor in place for easy removal and reinstallation with ordinary hand tools.
- B. Information and Safety Signs:
 - 1. Install facing traffic. Locate for high visibility with minimum restriction of working area around walkways and equipment.
- C. Hazardous Material Sign:
 - 1. Install where required by NFPA No. 704 and IFC, Chapter 50.
 - 2. Install at entrances to spaces where hazardous materials are stored, dispensed, used, or handled, and on sides of stationary tanks.
 - 3. Specific Materials:

Sign Schedule—Hazardous Material Signs								
Mark	Material	Health Hazard (Blue)	Flammability Hazard (Red)	Instability Hazard (Yellow)	Special Hazard (White)	Location	Mounting Method	Height to Top
H-1	Purate (Sodium Chlorate and Hydrogen Peroxide Blend - 45% solution)	3	0	1	OXY	Tank	Adhesive	5'-6"
H-2	Chlorine Dioxide Solution	3	3	3	--	Wall	Screws	5'-6"
H-3	Sulfuric Acid (12.7-50% solution)	3	0	1	COR, W	Tank	Adhesive	5'-6"

3.04 IDENTIFICATION LABELS

A. Pipe Labels:

1. Locate at connections to equipment, valves, or branching fittings at wall boundaries.
2. At intervals along piping not greater than 18 feet on center with at least one label applied to each exposed horizontal and vertical run of pipe.
3. At exposed piping not normally in view, such as above suspended ceilings and in closets and cabinets.
4. Supplementary Labels: Provide to Owner those listed on Piping Schedule that do not receive arrows.
5. Apply to pipe after painting in vicinity is complete, or as approved by Engineer.
6. Install in accordance with manufacturer's instructions.

B. Equipment Labels:

1. Locate and install on equipment or concrete equipment base.
2. Anchor to equipment or base for easy removal and replacement with ordinary hand tools.

3.05 SUPPLEMENTS

A. The supplement listed below, following "End of Section," is a part of this specification.

1. Sign Schedule: Tabulation of characteristics and mounting information for warning, and informational signs on Project. Provide items as scheduled. Meet requirements of Occupational Safety and Health Act (OSHA).

END OF SECTION

Sign Schedule

Sign															Lettering					Other Requirements
Number ¹	Sign Type ²	Detail Reference ³	Size		Color	Mounting			Height to Top	Lettering				Faces						
			Width	Height		Location	Method	Height		Style	Color	Message								
S-1	D	1014-001	14"	10"	White	Tank	Adhesive	5'-6"	1" min.	Helvetica	Black	DANGER Sodium Chlorate and Hydrogen Peroxide Blend	1	(1) at each Purate tank Type H Hazardous Material Sign						
S-10	D	1014-001	14"	10"	White	Tank	Adhesive	5'-6"	1" min.	Helvetica	Black	DANGER Sulfuric Acid	1	(1) at each sulfuric acid tank Type H Hazardous Material Sign						
S-11	A	1014-001	14"	10"	White	Wall	Bolts	5'-6"	1" min.	Helvetica	Black	DANGER Chlorine Dioxide In Use	1	(1) at Chlorine Dioxide System Room Type H Hazardous Material Sign						
S-12	A	N/A	As required		White	Pipe Post	Bolts	5'-6"	1" min.	Helvetica	Black	PURATE FILL STATION	1	(1) at chemical supply vehicle hose connection						
S-13	A	N/A	As required		White	Pipe Post	Bolts	5'-6"	1" min.	Helvetica	Black	SULFURIC ACID 78% FILL STATION	1	(1) at chemical supply vehicle hose connection						
S-23	A	1014-003	20"	14"	Orange	Wall or Pipe Post	Bolts	5'-6"	1" min.	Helvetica	Black	WARNING Corrosive Materials Wear Required Protection	1	(1) at Chlorine Dioxide System Room (4) at Bulk Storage Facility						
H-*	H	1014-006	10" min.	10" min.	See Detail	Tanks	Adhesive	5'-6"	4"	Block	Black	*	1	*See format detail and Spec Article, Signs						
N-1	N	N/A	As Required		Black	Door	Adhesive	5'-6"	1"	Helvetica	White	CHLORINE DIOXIDE SYSTEM ROOM	1	Chlorine Dioxide System Room door						

¹Numbers refer to a particular sign type with a particular message.²Letters refer to Sign Types specified in this section.³Numbers refer to Design Details that show sign layout.⁴Verify requirements for this sign with Regulations in state where Project is located.

SECTION 10 44 00
FIRE PROTECTION SPECIALTIES

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. National Fire Protection Association (NFPA): 10, Standard for Portable Fire Extinguishers.
2. Occupational Safety and Health Administration (OSHA).
3. Underwriters Laboratories Inc. (UL): Fire Protection Equipment Directory.

1.02 PERFORMANCE REQUIREMENTS

A. Conform to NFPA 10.

B. Provide extinguishers classified and labeled by Underwriters Laboratories Inc. for purpose specified and indicated.

1.03 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
 - a. Fire Extinguishers: Manufacturer's product data for each item, including sizes, ratings, UL listings, or other certifications, and mounting information.
 - b. Extinguisher Cabinets and Key Boxes: Indicate type of cabinet, cabinet physical dimensions, rough-in measurements for recessed and semi-recessed cabinets, wall bracket mounted measurements, location, fire ratings, mounting methods and anchorage details, relationship of cabinet box and trim to surrounding construction, door type and hardware, trim style, panel style.
 - c. Product Data: Extinguisher operational features, color and finish, and anchorage details.

B. Informational Submittals:

1. Manufacturer's Installation Instructions:
 - a. Special criteria and wall opening coordination requirements.
 - b. Manufacturer's installation details for fire-rated cabinets.
 - c. Cabinet location plan.

2. Manufacturer's Certificate: Certify Products meet or exceed specified requirements.
3. Operation and Maintenance Data: Submit test, refill or recharge schedules and recertification requirements.

1.04 ENVIRONMENTAL REQUIREMENTS

- A. Section 01 61 00, Common Product Requirements: Environmental conditions affecting products onsite.
- B. Do not install extinguishers when ambient temperatures are capable of freezing extinguisher ingredients.

PART 2 PRODUCTS

2.01 PORTABLE FIRE EXTINGUISHERS

- A. Manufacturers:
 1. JL Industries; Model Cosmic 10E.
 2. Larsen's Manufacturing Co.; Model MP10.
 3. Nystrom Products Co.; Model EX-3010.
 4. United Technologies Corp., Badger Fire; Model B10M.
- B. General:
 1. Conform to NFPA 10 for fire extinguishers.
 2. Furnish fire extinguishers and cabinets from one manufacturer.
 3. UL listed, charged and ready for service.
- C. Multipurpose Hand Extinguisher (F. Ext-1):
 1. Tri-class dry chemical extinguishing agent.
 2. Pressurized, red enameled steel shell cylinder.
 3. Activated by top squeeze handle.
 4. Agent propelled through hose or opening at top of unit.
 5. For use on A, B, and C class fires.
 6. Minimum UL Rating: 4A-80B: C, 10-pound capacity.

2.02 ACCESSORIES

- A. Extinguisher Brackets: For hand extinguishers not located in cabinets, furnish heavy-duty brackets with clip-together strap for wall mounting.
- B. Graphic Identification: Provide graphic identification marking for each fire extinguisher type. OSHA approved pictorial markings to indicate the extinguisher uses and non-uses on a single label.

- C. Fasteners: Furnish necessary screws, bolts, brackets, and other fastenings of suitable type and size to secure items of fire and safety equipment in position.
 - 1. Metal expansion shields for machine screws at concrete and masonry.
 - 2. Interior: Rust-resistant.
 - 3. Exterior: Stainless steel.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify brackets are correctly sized for fire extinguisher type.

3.02 INSTALLATION

- A. Install where indicated or directed and in accordance with manufacturer's recommendations.
- B. Secure brackets rigidly to structure.
- C. Provide adequate backing for mounting surfaces.
- D. Place extinguishers on wall brackets.
- E. Position signage as required by authorities having jurisdiction.

3.03 PORTABLE FIRE EXTINGUISHERS AND CABINETS

- A. Provide at locations shown or as directed by Engineer.
- B. Mount hangers securely in position, following manufacturer's recommendations.
- C. Top of Extinguisher: No more than 54 inches above floor.

END OF SECTION

**SECTION 10 73 00
PROTECTIVE COVERS**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Pre-engineered, pre-finished extruded aluminum walkway covers.
- B. Project Facility Name: Chlorine Dioxide Bulk Storage Canopy.

1.02 RELATED SECTIONS

- A. Section 01 61 00, Common Product Requirements.
- B. Section 01 88 15, Anchorage and Bracing.
- C. Section 03 30 00, Cast-In-Place Concrete.
- D. Section 03 62 00, Grouting.
- E. Section 05 50 00, Metal Fabrications.

1.03 REFERENCES

- A. American Architectural Manufacturers Association (AAMA):
 - 1. AAMA 605, Voluntary Specification for High Performance Organic Coatings on Architectural Extrusions and Panels.

1.04 DESIGN REQUIREMENTS

- A. Columns, Beams, Gutter Beams, Deck, and Trim: Aluminum extrusions.
- B. Structural Framing: Interlocking deck sections roll locked and secured by screws. Mechanically fastened bents using internally concealed bolted connections.
- C. Canopy: Self-draining from deck through bents to discharge point at belowground level stormwater piping or as otherwise shown.
- D. Covers shall be all extruded aluminum system complete with internal drainage in flat canopy configurations with roll lock roof deck components as indicated on the drawings. Roll form, wedge locked or crimped deck is not permitted.
- E. Building Code: International Building Code, 2012 with Georgia State Amendments.

F. Design Criteria:

1. Comply with the requirements in Section 01 61 00, Common Product Requirements.
2. Comply with Building Code for site location.
3. Collateral Loads: Additional loads imposed by other materials or systems identified in Contract Documents.
4. Maximum design deflections shall be:
 - a. Vertical deflection under total load: $1/180$ of the span.
 - b. Vertical deflection under live load: $1/240$ of the span.
 - c. Horizontal deflection of the frame: $1/120$ of the span.

G. Structural Design: Prepare complete structural design calculations for canopy members, including anchorage to the foundation, except footings. All protective covers, including columns, deck, and attachments to the concrete walkway slabs/foundations, shall be designed and detailed by a qualified professional engineer registered in the State of Georgia.

1.05 SUBMITTALS

A. Action Submittals:

1. Product Data: Manufacturer's catalog data, detail sheets, and specifications.
2. Shop Drawings: Scaled layout and erection drawings showing roof framing, deck panels, cross sections, trim details, and anchorage, clearly indicating proper assembly signed and sealed by a licensed engineer registered in the State of Georgia.
3. Loading diagrams.
4. Samples: Color selection samples consisting of actual coating material on aluminum extrusion for use to confirm matching of up to two manufacturer's standard colors.

B. Informational Submittals:

1. Complete design calculations for member stresses, deflections, connections and anchorage.
2. Qualifications: Letter certifying manufacturer's required qualifications.
3. Structural Design Calculations signed and sealed by a licensed engineer registered in the State of Georgia.
4. Manufacturer's Installation Instructions.

1.06 QUALITY ASSURANCE

- A. Overall Standard: Structural engineering shop drawings and design calculations stamped by a structural engineer registered to practice in the State of Georgia.
- B. Manufacturer Qualifications: Minimum 5 years' experience in producing covers/canopies with welded bents and of the type specified.
- C. Installer Qualifications: Minimum 2 years' experience in erecting covers/canopies of the type specified.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Conform to Section 01 61 00, Common Product Requirements.
- B. Follow manufacturer's instructions.

PART 3 PRODUCTS

2.01 MANUFACTURERS

- A. Acceptable Manufacturers:
 - 1. Perfection Architectural Systems, Inc., 2310 Mercator Drive, Orlando, FL 32807; ASD. Tel: (800) 238-7207, Fax: (407) 671-8252.
 - 2. Peachtree Protective Covers, 1477 Rosedale Drive, Hiram, GA 30141; Tel: (800) 341-3325.
 - 3. Mitchell Metals, 1761 McCoba Drive SE, Smyrna, GA 30080; Tel: (770) 766-5521, Fax: (770) 431-7305.
- B. Provide all protective covers from a single manufacturer.

2.02 MATERIALS

- A. Metals: In accordance with Section 05 50 00, Metal Fabrications, except Aluminum Extrusions shall be 6063 alloy, T-6 temper.
- B. Grout: In accordance with Type II of Section 03 62 00, Nonshrink Grouting.
- C. Foam Block-Outs: Rigid foam blocks sized as required for column embedment depth and shape.

2.03 COMPONENTS

A. Columns:

1. Radius-cornered aluminum tubular extrusion of size shown on Drawings.
2. Radius-cornered aluminum tubular extrusion as required by structural engineering design.
3. Grout Key: Provide two 1-1/2-inch diameter holes in column base, one each in opposite sides.
4. Provide clear acrylic protection coat on surfaces in contact with grout.

B. Beams: Open top aluminum tubular extrusions.

1. Size: As required by structural engineering design.

C. Deck: Rigid-Roll-Lock extruded aluminum, self-flashing, interlocking sections.

1. Size: As required by structural engineering design.
2. Provide welded endplate water dams where sections terminate at other than drainage channels. Sealed or caulked in place dams are not acceptable.

D. Fascia: As required to complete the installation resulting in a neat finished appearance.

E. Flashing: Aluminum sheet, thickness as recommended by manufacturer for specific condition.

2.04 ACCESSORIES

A. Fasteners:

1. Deck Screws: No. 14 by 1 inch, self-tapping, Type 18-8 stainless steel with neoprene washers.
2. Trim Screws: No. 10 by 1/2 inch, self-tapping, Type 18-8 stainless steel.
3. Trim Rivets: Aluminum, size recommended by manufacturer for specific condition.
4. Other Fasteners: Type 18-8 stainless steel, type recommended by manufacturer for specific condition.

B. Anchors: In accordance with Section 05 50 00, Metal Fabrications, minimum 1/2-inch diameter.

C. Underground Stormwater Pipe: Aluminum pipe mounted to column drain outlet for connection to underground stormwater piping.

2.05 FABRICATION

- A. Shop Assembly: Fabricate cross beams and columns for field assembled bolted connections.

2.06 FINISHES

- A. Fluoropolymer Coating: 70 percent PVDF resin based fluoropolymer, AA-C-12C-42R-1, color as selected by architect from manufacturers standard colors, nonmetallic, comply with AAMA 605.
 - 1. Two coat application.
 - 2. Maximum of two Manufacturer's standard colors as required by Owner.

PART 3 EXECUTION**3.01 EXAMINATION**

- A. Examine footings in which bents will be set. Verify footing locations and elevations comply with Shop Drawings.
- B. Coordinate with responsible trade to perform corrective work on unsatisfactory footings or surfaces.
- C. Commencement of work by installer is acceptance of existing conditions.

3.02 ERECTION

- A. Erect protective covers in accordance with manufacturer's installation instructions.
- B. Set bents plumb, straight, and true to line, adequately braced to maintain position until grout has cured.
- C. Keep aluminum surfaces from direct contact with ferrous metal or other incompatible materials by applying one coat of clear acrylic coating.
- D. Field connections shall be bolted or fastened. Field welding will not be permitted.

3.03 CLEANING

- A. Clean surfaces soiled by work as recommended by manufacturer.
- B. Remove surplus materials and debris from the site.

3.04 PROTECTION

- A. Protect finished aluminum surfaces from damage due to subsequent construction operations.

END OF SECTION

SECTION 22 40 00
PLUMBING FIXTURES

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. Americans with Disabilities Act (ADA).
2. American Gas Association (AGA).
3. American Society of Mechanical Engineers (ASME).
4. American Society of Sanitary Engineering (ASSE): 1010, Performance Requirements for Water Hammer Arresters.
5. ASTM International (ASTM): D4101, Standard Specification for Polypropylene Injection and Extrusion Materials.
6. Food and Drug Administration (FDA).
7. NSF International (NSF):
 - a. NSF/ANSI 61, Drinking Water System Components - Health Effects.
 - b. NSF/ANSI 372, Drinking Water System Components - Lead Content.
8. Plumbing and Drainage Institute (PDI):
 - a. Code Guide 302 and Glossary of Industry Terms.
 - b. WH-201, Water Hammer Arrester Standard.
9. Underwriters Laboratories Inc. (UL).

1.02 SUBMITTALS

A. Action Submittals: Catalog information and rough-in dimensions for plumbing fixtures, products, and specialties.

1.03 REGULATORY REQUIREMENTS

A. Comply with the Americans with Disabilities Act (ADA), and local and state requirements.

PART 2 PRODUCTS

2.01 GENERAL

- A. Components and Materials in Contact with Water for Human Consumption: Comply with the requirements of the Safe Drinking Water Act and other applicable federal, state, and local requirements. Provide certification by manufacturer or an accredited certification organization recognized by the Authority Having Jurisdiction that components and materials comply with the maximum lead content standard in accordance with NSF/ANSI 61 and NSF/ANSI 372.
 - 1. Use or reuse of components and materials without a traceable certification is prohibited.

2.02 MANUFACTURERS

- A. Emergency Shower and Eyewashe:
 - 1. Haws.
 - 2. Western.
 - 3. Guardian.

2.03 GENERAL

- A. Plumbing Fixtures: Indicated by fixture number as shown on Drawings.
- B. Plumbing Specialties: Indicated by fixture number as shown on Drawings.

2.04 MATERIALS

- A. Safety Equipment:
 - 1. SSH-200-1, Safety Shower/Eyewash Combination (Freeze-proof):
 - a. Model: Haws Drinking Faucet Co.; Model 8317CTFPT.
 - b. Shower: ABS plastic deluge.
 - c. Eyewash: Stainless steel bowl with aerated eye/face wash.
 - d. Valve: Stay open.
 - e. Support: Freestanding, 1-1/4-inch galvanized pipe standard, stanchion, and floor flange, cable heated and insulated.
 - f. Accessories:
 - 1) Provide Emergency Alarm System Model 9001.
 - a) Power: 120V ac.
 - b) Alarms:
 - (1) Flow Switch with contact output to indicate shower is in use.
 - (2) Horn.
 - (3) Strobe.

- B. Hose Valves: Refer to Section 40 27 02, Process Valves and Operators.
- C. Sealant: In accordance with Section 07 92 01, Sealants and Caulking.

PART 3 EXECUTION

3.01 PREPARATION

- A. Drawings do not attempt to show exact details of fixtures. Changes in locations of fixtures, advisable in opinion of Contractor, shall be submitted to Engineer for review before proceeding with the Work.

3.02 INSTALLATION

- A. Plumbing Fixtures, Mounting Heights:
 - 1. Standard rough-in catalogued heights, unless shown otherwise on Drawings.
 - 2. Caulk fixtures in contact with finished walls with waterproof, white, nonhardening sealant which will not crack, shrink, or change color with age. See Section 07 92 00, Joint Sealants.
- B. Exact fixture location and mounting arrangement shall be as indicated on toilet room elevations and details as shown on Drawings.
- C. Unless noted otherwise and as a minimum, fixtures shall be supported as indicated in PDI Code Guide 302.
- D. Safety Shower:
 - 1. System Shutoff Valves:
 - a. Shutoff valves shall give visual indication of position (open or closed).
 - b. Shutoff valves shall be lockable valves and locked in open position.
 - 2. Each safety shower, eyewash, combination safety shower/eyewash shall have red safety signoff tag. After completing requirements listed below, Contractor and Owner shall sign red safety signoff tag. Requirements are as follows:
 - a. Visually check safety shower/eyewash piping for leaks.
 - b. Verify that upon operation, stay-open valves remain open.
 - c. Showerheads to be between 82 inches and 96 inches above standing surface.
 - d. Shower spray pattern, when valve is full open, shall be a minimum 20 inches in diameter at 60 inches above standing surface.

- e. Water arcs from eyewash spray heads must cross. Test with eyewash gauge; Haws Drinking Faucet Co., Model 9015.
 - f. Minimum flow rates for safety showers shall be 20 gpm.
 - g. Minimum flow rates for eyewashes shall be 3 gpm.
 - h. Tempered water shall be temperature indicated on Drawings.
- E. Caulk penetrations of exterior walls with weatherproof sealant in accordance with Section 07 92 00, Joint Sealants.
- F. Adjust water flows in domestic water systems for reasonable water flows at each plumbing fixture, terminal device, and recirculation loop. Flush valve fixtures shall be adjusted for proper flush cycle time and water quantity.

3.03 FIELD QUALITY CONTROL

- A. Perform visual inspection for physical damage, blocked access, cleanliness, and missing items.
- B. Notify Owner and Engineer 48 hours prior to shower testing. Owner and Engineer reserve the right to witness all tempered water and safety shower testing.
- C. Test safety shower and eyewash units. Water flow must be tested at both showerhead and eyewash/face ring.
 - 1. Shower Flow:
 - a. Test with tube-type water gauge (Haws Drinking Faucet Co., Model 9010) and 5-gallon container.
 - b. Container shall fill in 10 seconds or less, with a minimum 20-gpm flow.
 - 2. Eyewash Flow:
 - a. Test with tube-type water gauge (Haws Drinking Faucet Co., Model 9010) and 1-gallon container.
 - b. Container shall fill in 20 seconds or less.
 - 3. Contractor shall log, date, and initial inspection upon passing flow tests.
- D. Verify alarm operation both locally and systemwide. Notify security prior to test if alarm is connected systemwide.

END OF SECTION

SECTION 26 05 01
ELECTRICAL

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American Association of State Highway Transportation Officials (AASHTO).
2. ASTM International (ASTM):
 - a. A167, Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.
 - b. A240/A240M, Standard Specification for Heat-Resisting Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels.
 - c. A1011/A1011M, Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability.
 - d. B8, Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft.
 - e. C857, Standard Practice for Minimum Structural Design Loading for Underground Precast Concrete Utility Structures.
3. Electronic Industries Association (EIA/TIA): 569, Commercial Building Standard for Telecommunications Pathways and Spaces.
4. Federal Specifications (FS):
 - a. W-C-596, Connector, Electrical, Power, General Specification for.
 - b. W-S-896, Switch, Toggle (Toggle and Lock), Flush Mounted (General Specification).
5. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
 - a. C62.41, Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits.
 - b. PC62.41.1, Draft Guide on the Surge Environment in Low-Voltage (1,000 V and less) AC Power Circuits.
 - c. 112, Standard Test Procedure for Polyphase Induction Motors and Generators.
 - d. 114, IEEE Standard Test Procedure for Single-Phase Induction Motors.
6. International Electrical Testing Association (NETA): ATS, Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.
7. National Electrical Contractor's Association, Inc. (NECA): 1, Standard Practices for Good Workmanship in Electrical Contracting.

8. National Electrical Manufacturers Association (NEMA):
 - a. C80.1, Rigid Steel Conduit-Zinc Coated.
 - b. C80.3, Electrical Metallic Tubing-Zinc Coated.
 - c. C80.6, Intermediate Metal Conduit-Zinc Coated (IMC).
 - d. 250, Enclosures for Electrical Equipment (1,000 Volts Maximum).
 - e. CC1, Electrical Power Connectors for Substations.
 - f. ICS 1, Industrial Control and Systems: General Requirements.
 - g. ICS 2, Industrial Control and Systems: Controllers, Contactors, and Overload Relays Rated Not More Than 2000 Volts AC or 750 Volts DC.
 - h. ICS 2.3, Industrial Control and Systems: Instructions for the Handling, Installation, Operation and Maintenance of Motor Control Centers.
 - i. MG 1, Motors and Generators.
 - j. PB 1, Panelboards.
 - k. RN 1, Polyvinyl Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit.
 - l. ST 20, Dry Type Transformers for General Applications.
 - m. TC 2, Electrical Polyvinyl Chloride (PVC) Tubing and Conduit.
 - n. TC 3, PVC Fittings for Use with Rigid PVC Conduit and Tubing.
 - o. WC 55, Instrumentation Cables and Thermocouple Wire.
 - p. WC 70, Standard for Non-Shielded Power Cables Rated 2000 V or Less for the Distribution of Electrical Energy.
 - q. WC 71, Standard for Non-Shielded Cables Rated 2001-5000 Volts for use in the Distribution of Electrical Energy.
 - r. WC 74, 5-46 KV Shielded Power Cable for use in the Transmission and Distribution of Electric Energy.
 - s. WD 1, General Color Requirements for Wiring Devices.
9. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC).
10. Underwriters Laboratories, Inc. (UL):
 - a. 1, Flexible Metal Conduit.
 - b. 6, Electrical Rigid Metal Conduit—Steel.
 - c. 13, Power-Limited Circuit Cables.
 - d. 44, Thermoset Insulated Wires and Cables.
 - e. 62, Flexible Cord and Fixture Wire.
 - f. 67, Panelboards.
 - g. 98, Enclosed and Dead-Front Switches.
 - h. 198C, High Interrupting Capacity Fuses, Current Limiting Types.
 - i. 198E, Class R Fuses.
 - j. 360, Liquid-Tight Flexible Steel Conduit.
 - k. 486A, Wire Connectors and Soldering Lugs for Use with Copper Conductors.
 - l. 486C, Splicing Wire Connectors.

- m. 489, Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit Breaker Enclosures.
- n. 508, Industrial Control Equipment.
- o. 510, Polyvinyl Chloride, Polyethylene and Rubber Insulating Tape.
- p. 514B, Fittings for Cable and Conduit.
- q. 651, Schedule 40 and 80 PVC Conduit.
- r. 674, Electric Motors And Generators for use in Division 1 Hazardous (Classified) Locations.
- s. 797, Electrical Metallic Tubing.
- t. 854, Service-Entrance Cables.
- u. 870, Wireways, Auxiliary Gutters, and Associated Fittings.
- v. 943, Ground-Fault Circuit Interrupters.
- w. 1059, Terminal Blocks.
- x. 1242, Intermediate Metal Conduit.
- y. 1277, Electrical Power and Control Tray Cables with Optional Optical-Fibre Members.
- z. 1449, Transient Voltage Surge Suppressors.
- aa. 1561, Dry-Type General Purpose and Power Transformers.
- bb. 2111, Overheating Protection for Motors.

1.02 DEFINITIONS

- A. AHJ: Authority Having Jurisdiction.
- B. MCOV: Maximum Allowable Continuous Operating Voltage.
- C. MOV: Metal Oxide Varistor.
- D. SASD: Silicon Avalanche Suppressor Diode.
- E. SVR: Surge Voltage Rating.
- F. SPD: Surge Protective Device.

1.03 SUBMITTALS

- A. Action Submittals:
 - 1. Boxes and device plates.
 - 2. Junction and pullboxes.
 - 3. Precast handholes.
 - 4. Wiring devices.
 - 5. Panelboards and mini-power centers.
 - 6. Circuit breakers and switches.
 - 7. Motor-rated switches.
 - 8. Control devices, terminal blocks, and relays.

9. Transformers.
10. Support and framing channels.
11. Nameplates and nameplate schedule.
12. SPD equipment.
13. Conduit, fittings, and accessories.
14. Wireways.
15. Conductors, cable, and accessories.
16. Grounding materials.
17. Luminaires.
18. Lighting controls.

B. Informational Submittals:

1. Seismic anchorage and bracing calculations as required by Section 01 88 15, Anchorage and Bracing.
2. Component and attachment testing seismic certificate of compliance as required by Section 01 45 33, Special Inspection, Observation, and Testing.
3. Factory test reports.
4. Field test reports.
5. Signed permits indicating Work is acceptable to regulatory authorities having jurisdiction.
6. Operation and Maintenance Data:
 - a. As specified in Section 01 78 23, Operation and Maintenance Data.
 - b. Provide for all equipment, as well as each device having features that can require adjustment, configuration, or maintenance.
 - c. Minimum information shall include manufacturer's preprinted instruction manual, one copy of the approved submittal information for the item, tabulation of any settings, and copies of any test reports.

1.04 APPROVAL BY AUTHORITY HAVING JURISDICTION

- A. Provide the Work in accordance with NFPA 70, National Electrical Code (NEC). Where required by the Authority Having Jurisdiction (AHJ), material and equipment shall be labeled or listed by a nationally recognized testing laboratory or other organization acceptable to the AHJ, in order to provide a basis for approval under the NEC.
- B. Materials and equipment manufactured within the scope of standards published by Underwriters Laboratories, Inc., shall conform to those standards and shall have an applied UL listing mark or label.

1.05 QUALIFICATIONS

- A. PVC-Coated, Rigid Steel Conduit Installer: Must be certified by conduit manufacturer as having received minimum 2 hours of training on installation procedures.

1.06 ENVIRONMENTAL CONDITIONS

- A. The following areas are classified nonhazardous, wet, and corrosive. Use materials and methods required for such areas:
 - 1. Area within Chemical Building
 - 2. Chemical Tank Containment Area
 - 3. Chemical Tank Fill Station Area
- B. The following areas are classified nonhazardous and wet. Use materials and methods required for such areas: Outdoor abovegrade areas not covered above.
- C. The following areas are not classified. Use dust-tight and oil-tight NEMA 12 materials and methods: Electrical Room.

PART 2 PRODUCTS

2.01 GENERAL

- A. Products shall comply with all applicable provisions of NFPA 70.
- B. Like Items of Equipment: End products of one manufacturer in order to achieve standardization for appearance, operation, maintenance, spare parts, and manufacturer's service.
- C. Equipment and Devices Installed Outdoors or in Unheated Enclosures: Capable of continuous operation within ambient temperature range of 0 degrees F to 104 degrees F.
- D. Equipment Finish: Manufacturer's standard finish color, except where specific color is indicated.

2.02 OUTLET AND DEVICE BOXES

- A. Cast Metal:
 - 1. Box: Cast ferrous metal.
 - 2. Cover: Gasketed, weatherproof, and cast ferrous metal with stainless steel screws.
 - 3. Hubs: Threaded.
 - 4. Lugs: Cast Mounting.

5. Manufacturers and Products, Nonhazardous Locations:
 - a. Crouse-Hinds; Type FS or FD.
 - b. Appleton; Type FS or FD.
6. Manufacturers and Products, Hazardous Locations:
 - a. Crouse-Hinds; Type GUA or EAJ.
 - b. Appleton; Type GR.

B. PVC-Coated Cast Metal:

1. Type: One-piece.
2. Material: Malleable iron, cast ferrous metal, or cast aluminum.
3. Coating:
 - a. All Exterior Surfaces; 40 mils PVC.
 - b. All Interior Surfaces, 2 mils urethane.
4. Manufacturers:
 - a. Robroy Industries.
 - b. Ocal.

2.03 JUNCTION AND PULL BOXES

- A. Outlet Boxes Used as Junction or Pull Box: As specified under Article Outlet and Device Boxes.
- B. Conduit Bodies Used as Junction Boxes: As specified under Article Conduit and Fittings.
- C. Large Stainless Steel Box:
 1. NEMA 250, Type 4X.
 2. Box: 14-gauge, ASTM A240, Type 316 stainless steel.
 3. Cover: Hinged with clamps.
 4. Hardware and Machine Screws: ASTM A167, Type 316 stainless steel.
 5. Manufacturers:
 - a. Hoffman Engineering Co.
 - b. Robroy Industries.
- D. Concrete Box, Nontraffic Areas:
 1. Box: Reinforced, cast concrete with extension.
 2. Cover: Steel diamond plate with locking bolts.
 3. Cover Marking: ELECTRICAL, TELEPHONE, or as shown.
 4. Size: 10 inch by 17 inch (minimum).
 5. Manufacturer and Product: Utility Vault Co.; Series 36-1017PB, with cover DP.

2.04 WIRING DEVICES

A. Switches:

1. NEMA WD 1 and FS W-S-896.
2. Industrial grade, totally enclosed, ac type, with quiet tumbler switches and screw terminals.
3. Capable of controlling 100 percent tungsten filament and fluorescent lamp loads.
4. Rating: 20 amps, 120/277 volts.
5. Automatic grounding clip and integral grounding terminal on mounting strap.
6. Manufacturers and Products:
 - a. Leviton; 1221 Series.
 - b. Bryant; 4901 Series.
 - c. Hubbell; 1221 Series.

B. Receptacle, Single and Duplex:

1. NEMA WD 1 and FS W-C-596.
2. Specification grade, two-pole, three-wire grounding type with screw type wire terminals suitable for No. 10 AWG.
3. High strength, thermoplastic base color.
4. Contact Arrangement: Contact to be made on two sides of each inserted blade without detent.
5. Rating: 125 volts, NEMA WD 1, Configuration 5-20R, 20 amps.
6. One-piece mounting strap with integral ground contact (rivetless construction).
7. Manufacturers and Products:
 - a. Arrow Hart; 5262 Series.
 - b. Leviton; 5262/5362 Series.
 - c. Bryant; 5262/5362 Series.
 - d. Hubbell; 5262/5362 Series.

C. Receptacle, Ground Fault Circuit Interrupter:

1. Duplex, listed Class A to UL Standard 943, tripping at 5 mA.
2. Rating: 125 volts, NEMA WD 1, Configuration 5-20R, 20 amps.
3. Size: For 2-inch by 4-inch outlet boxes.
4. Standard Model: NEMA WD 1, with screw terminals and provisions for testing.
5. Feed-Through Model: NEMA WD 1, with feed-through screw terminals and provisions for testing.
6. Impact resistant nylon face.

7. Manufacturers:
 - a. Bryant.
 - b. Hubbell.
 - c. Leviton.

2.05 DEVICE PLATES

- A. General: Sectional type plates not permitted.
- B. Plastic:
 1. Material: Specification grade, 0.10-inch minimum thickness, noncombustible, thermosetting.
 2. Color: To match associated wiring device.
 3. Mounting Screw: Oval-head metal, color matched to plate.
- C. Cast Metal:
 1. Material: Malleable ferrous metal with gaskets.
 2. Screw: Oval-head stainless steel.
- D. Engraved:
 1. Character Height: 1/8 inch.
 2. Filler: Black.
- E. Weatherproof:
 1. For Receptacles, Wet Locations:
 - a. Impact-resistant, nonmetallic, single-gang, horizontal-mounting, providing, while in-use, NEMA 3R rating.
 - b. Stainless steel mounting and hinge hardware.
 - c. Lockable, paintable.
 - d. Color: Gray.
 - e. Manufacturers:
 - 1) Carlon.
 - 2) Leviton.
 2. For Switches:
 - a. Gasketed, cast-metal or cast-aluminum, incorporating external operator for internal switch.
 - b. Mounting Screw: Stainless steel.
 - c. Manufacturers and Products:
 - 1) Crouse-Hinds; DS-181 or DS-185.
 - 2) Appleton; FSK-1VTS or FSK-1VS.

2.06 LIGHTING AND POWER DISTRIBUTION PANELBOARD

- A. NEMA PB 1, NFPA 70, and UL 67.
- B. Panelboards and Circuit Breakers: Suitable for use with 75 degrees C wire at full NFPA 70, 75 degrees C ampacity.
- C. Short-Circuit Current Equipment Rating: Fully rated; series connected unacceptable.
- D. Rating: Applicable to a system with available short-circuit current of 10,000 amperes rms symmetrical at 208Y/120 or 120/240 volts and 50,000 amperes rms symmetrical at 480Y/277 volts.
- E. Cabinet:
 - 1. NEMA 250, Type 1, unless shown otherwise.
 - 2. Material: Code-gauge, hot-dip galvanized sheet steel with reinforced steel frame.
 - 3. Wiring Gutter: Minimum 4-inch square; both sides, top and bottom.
 - 4. Front: Fastened with adjustable clamps.
 - a. Trim Size: As required by mounting.
 - b. Finish: Manufacturer's standard.
 - 5. Interior:
 - a. Factory assembled; complete with circuit breakers.
 - b. Spaces: Cover openings with easily removable metal cover.
 - 6. Door Hinges: Concealed.
 - 7. Locking Device:
 - a. Flush type.
 - b. Doors Over 30 Inches in Height: Multipoint.
 - c. Identical keylocks, with two milled keys each lock.
 - 8. Circuit Directory: Metal frame with transparent plastic face and enclosed card on interior of door.
- F. Bus Bar:
 - 1. Material: Copper full sized throughout length.
 - 2. Neutral: Insulated, rated same as phase bus bars with at least one terminal screw for each branch circuit.
 - 3. Ground: Copper, installed on panelboard frame, bonded to box with at least one terminal screw for each circuit.
 - 4. Lugs and Connection Points:
 - a. Suitable for either copper or aluminum conductors.
 - b. Solderless main lugs for main, neutral, and ground bus bars.
 - c. Subfeed or through-feed lugs as shown.

G. Circuit Breakers:

1. UL 489.
2. Thermal-magnetic, quick-make, quick-break, molded case, of indicating type showing ON/OFF and TRIPPED positions of operating handle.
3. Type: Bolt-on circuit breakers in all panelboards.
4. Multipole circuit breakers designed to automatically open all poles when an overload occurs on one pole.
5. Do not use tandem or dual circuit breakers in normal single-pole spaces.
6. Ground Fault Circuit Interrupter (GFCI): UL Class A GFCI, 5 mA trip, and 10,000 amps interrupting capacity circuit breakers.
7. Ground Fault Equipment Protector (GFEP): 30 mA trip, 10,000 amps interrupting capacity circuit breaker, and UL listed for equipment ground fault protection.

H. Manufacturers:

1. General Electric Co.
2. Eaton.
3. Square D Co.

2.07 CIRCUIT BREAKER, INDIVIDUAL, 0 TO 600 VOLTS

- A. UL 489 listed for use at location of installation.
- B. Minimum Interrupt Rating: As shown.
- C. Thermal-magnetic, quick-make, quick-break, indicating type showing ON/OFF and TRIPPED indicating positions of operating handle.
- D. Suitable for use with 75 degrees C wire at full NFPA 70, 75 degrees C ampacity.
- E. Locking: Provisions for padlocking handle.
- F. Enclosure: As specified under Execution.
- G. Interlock: Enclosure and switch shall interlock to prevent opening cover with breaker in the ON position.
- H. Manufacturers:
 1. General Electric Co.
 2. Eaton.
 3. Square D Co.

2.08 FUSED SWITCH, INDIVIDUAL, 0 TO 600 VOLTS

- A. UL 98 listed for use and location of installation.
- B. NEMA KS 1 and UL 98 Listed for application to system with available short-circuit current of 42,000 amps rms symmetrical.
- C. Quick-make, quick-break, motor rated, load-break, heavy-duty (HD) type with external markings clearly indicating ON/OFF positions.
- D. Suitable for use with 75 degrees C wire at full NFPA 70, 75 degrees C ampacity.
- E. Fuse mountings shall reject Class H fuses and accept only current-limiting fuses specified.
- F. Enclosure: As specified under Execution.
- G. Interlock: Enclosure and switch to prevent opening cover with switch in ON position.
- H. Manufacturers:
 - 1. General Electric Co.
 - 2. Eaton.
 - 3. Square D Co.

2.09 NONFUSED SWITCH, INDIVIDUAL, 0 TO 600 VOLTS

- A. NEMA KS 1.
- B. Quick-make, quick-break, motor rated, load-break, heavy-duty (HD) type with external markings clearly indicating ON/OFF positions.
- C. Suitable for use with 75 degrees C wire at full NFPA 70, 75 degrees C ampacity.
- D. Enclosure: As specified under Execution.
- E. Interlock: Enclosure and switch to prevent opening cover with switch in the ON position.
- F. Manufacturers:
 - 1. General Electric Co.
 - 2. Eaton.
 - 3. Square D Co.

2.10 SWITCH, MOTOR-RATED

- A. Type: Two- or three-pole, manual motor starting/disconnect switch without overload protection.
- B. Enclosure/Mounting and Rating:
 - 1. General Purpose:
 - a. Totally enclosed snap-action switch. Quick-make, slow-break design with silver alloy contacts. Listed UL 508.
 - b. General Purpose Rating: 30 amperes, 600V ac.
 - c. Minimum Motor Ratings:
 - 1) 2 hp for 120V ac, single-phase, two-pole.
 - 2) 3 hp for 240V ac, single-phase, two-pole.
 - 3) 15 hp for 480V ac, three-phase, three-pole.
 - d. Screw-type terminals.
- C. Manufacturers:
 - 1. General Purpose:
 - a. Bryant.
 - b. Hubbell.

2.11 FUSE, 0 TO 600 VOLTS

- A. Current-limiting, with 200,000 ampere rms interrupting rating.
- B. Provide to fit mountings specified with switches and features to reject Class H fuses.
- C. Motor and Transformer Circuits, 0 to 600 Volt:
 - 1. Amperage: 0 to 600.
 - 2. UL 198E, Class RK-1, dual element, with time delay.
 - 3. Manufacturers and Products:
 - a. Bussmann; Type LPS-RK.
 - b. Littelfuse, Inc.; Type LLS-RK.
- D. Feeder and Service Circuits, 0 to 600 Volt:
 - 1. Amperage: 0 to 600.
 - 2. UL 198E, Class RK-1, dual element, with time delay.
 - 3. Manufacturers and Products:
 - a. Bussmann; Type LPS-RK.
 - b. Littelfuse, Inc.; Type LLS-RK.

- E. Feeder and Service Circuits, 0 to 600 Volt:
 - 1. Amperage: 601 to 6,000.
 - 2. UL 198C, Class L, double O-rings and silver links.
 - 3. Manufacturers and Products:
 - a. Bussmann; Type KRP-C.
 - b. Littelfuse, Inc.; Type KLPC.

2.12 PUSHBUTTONS, INDICATING LIGHTS, AND SELECTOR SWITCHES

- A. Type: Heavy-duty, oiltight. Provide contact arrangements, colors, inscriptions, and functions as shown.
- B. Contact Rating: NEMA ICS 2, Type A600.
- C. Unless otherwise shown, provide the following features:
 - 1. Selector Switch Operating Lever: Standard.
 - 2. Indicating Lights: Push-to-test, transformer-type.
 - 3. Pushbutton Color:
 - a. ON or START: Black.
 - b. OFF or STOP: Red.
 - 4. Pushbuttons and selector switches lockable in OFF position where indicated.
- D. Legend Plate:
 - 1. Material: Aluminum.
 - 2. Engraving: Indicating specific function, or as shown.
 - 3. Letter Height: 7/64 inch.
- E. Manufacturers and Products:
 - 1. General Electric Co.; Type CR 104P.
 - 2. Square D Co.; Type T.
 - 3. Eaton; Type 10250T.

2.13 TERMINAL BLOCKS

- A. Type: UL 1059. Compression screw clamp, with current bar providing direct contact with wire and yoke, with individual rail mounted terminals. Marking system shall permit use of preprinted or field-marked tags.
- B. Yokes and Clamping Screws: Zinc-plated, hardened steel.
- C. Rating: 600V ac.

D. Manufacturers:

1. Weidmuller, Inc.
2. Ideal.

2.14 DRY TYPE POWER TRANSFORMERS (0- TO 600-VOLT PRIMARY)

A. Type: Self-cooled, two-winding.

B. UL 1561 and NEMA ST 20.

C. Insulation Class, Temperature Rise, and Impedance: Manufacturer's standard.

D. Core and Coil:

1. 30 kVA or Less: Encapsulated.
2. 37.5 kVA and Larger: Varnish impregnated.

E. Enclosure:

1. 30 kVA or Less: NEMA 250, Type 3R, nonventilated.
2. 37.5 kVA and Larger: NEMA 250, Type 2, ventilated.

F. Voltage Taps: Full capacity, 2-1/2 percent, two above and two below normal voltage rating.

G. Sound Level: Not to exceed NEMA ST 20 levels.

H. Vibration isolators to minimize and isolate sound transmission.

I. Manufacturers:

1. General Electric.
2. Eaton.
3. Square D.

2.15 SUPPORT AND FRAMING CHANNELS

A. Stainless Steel Framing Channel: Rolled, ASTM A167, Type 316 stainless steel, 12 gauge.

B. Manufacturers:

1. B-Line Systems, Inc.
2. Unistrut Corp.

2.16 NAMEPLATES

- A. Material: Laminated plastic.
- B. Attachment: Adhesive.
- C. Color: Black, engraved to a white core, or as shown.
- D. Engraving:
 - 1. Devices and Equipment: Name or tag shown, or as required.
 - 2. Panelboards:
 - a. Designation.
 - b. Service voltage.
 - c. Phases.
 - 3. Minimum Requirement: Label metering and power distribution equipment, local control panels, junction boxes, motor controls, and transformers.
- E. Letter Height:
 - 1. Pushbuttons, Selector Switches, and Other Devices: 1/8 inch.
 - 2. Equipment and Panelboards: 1/4 inch.

2.17 CONDUIT AND FITTINGS

- A. Rigid Galvanized Steel Conduit (RGS):
 - 1. Meet requirements of NEMA C80.1 and UL 6.
 - 2. Material: Hot-dip galvanized, with chromated protective layer.
- B. PVC Schedule 40 Conduit:
 - 1. Meet requirements of NEMA TC 2 and UL 651.
 - 2. UL listed for concrete encasement, underground direct burial, concealed, or direct sunlight exposure, and 90 degrees C insulated conductors.
- C. PVC-Coated Rigid Galvanized Steel Conduit:
 - 1. Meet requirements of NEMA RN 1.
 - 2. Material:
 - a. Meet requirements of NEMA C80.1 and UL 6.
 - b. Exterior Finish : PVC coating, 40 mils nominal thickness, bond to metal shall have tensile strength greater than PVC.
 - c. Interior finish: Urethane coating, 2 mils nominal thickness.
 - 3. Threads: Hot-dipped galvanized and factory coated with urethane.
 - 4. Bendable without damage to either interior or exterior coating.

D. Flexible Metal, Liquid-Tight Conduit:

1. UL 360 listed for 105 degrees C insulated conductors.
2. Material: Galvanized steel, with an extruded PVC jacket.

E. Fittings:

1. Provide bushings, grounding bushings, conduit hubs, conduit bodies, couplings, unions, conduit sealing fittings, drain seals, drain/breather fittings, expansion fittings, and cable sealing fittings, as applicable.
2. Rigid Galvanized Steel Conduit:
 - a. Meet requirements of UL 514B.
 - b. Type: Threaded, galvanized.
3. Electrical Metallic Tubing:
 - a. Meet requirements of UL 514B.
 - b. Type: Steel body and locknuts with steel or malleable iron compression nuts. Setscrew and drive-on fittings not permitted.
 - c. Electro zinc-plated inside and out.
 - d. Raintight.
4. PVC Conduit:
 - a. Meet requirements of NEMA TC 3.
 - b. Type: PVC, slip-on.
5. PVC-Coated Rigid Galvanized Steel Conduit:
 - a. Meet requirements of UL 514B.
 - b. Fittings: Rigid galvanized steel type, PVC-coated by conduit manufacturer.
 - c. Conduit Bodies: Cast metal hot-dipped galvanized or urethane finish. Cover shall be of same material as conduit body. PVC-coated by conduit manufacturer.
 - d. Finish: 40-mil PVC exterior, 2-mil urethane interior.
 - e. Overlapping pressure sealing sleeves.
 - f. Conduit Hangers, Attachments, and Accessories: PVC-coated.
 - g. Manufacturers:
 - 1) Robroy Industries.
 - 2) Ocal.
 - h. Expansion Fitting Manufacturer and Product: Ocal; Ocal-Blue XJG.
6. Flexible Metal, Liquid-Tight Conduit:
 - a. Metal insulated throat connectors with integral nylon or plastic bushing rated for 105 degrees C.
 - b. Insulated throat and sealing O-rings.

2.18 CONDUIT ACCESSORIES

A. Identification Devices:

1. Raceway Tags:
 - a. Material: Permanent, nylon or polyethylene.
 - b. Shape: Round.
 - c. Raceway Designation: Pressure stamped, embossed, or engraved.
 - d. Tags relying on adhesives or taped-on markers not permitted.
2. Warning Tape:
 - a. Material: Polyethylene, 4-mil gauge with detectable strip.
 - b. Color: Red.
 - c. Width: Minimum 3 inches.
 - d. Designation: Warning on tape that electric circuit is located below tape.
 - e. Identifying Letters: Minimum 1-inch high permanent black lettering imprinted continuously over entire length.

B. Raceway Band:

1. Slip-on Type:
 - a. Provide heat-shrinkable, black, medium-wall polyolefin tubing with factory-applied adhesive/sealant. Select product size based upon raceway outside diameter.
 - b. Manufacturer and Product: 3M; Type IMCSN, medium wall cable sleeve.
2. Wrap-around Type:
 - a. Provide 4-inch width, 20-mil thickness, nonprinted black PVC corrosion protection tape with primer.
 - b. Manufacturer and Product: 3M; Type Scotchrap 51 with Scotchrap Pipe Primer.

2.19 CONDUCTORS AND CABLES

A. Conductors 600 Volts and Below:

1. Conform to applicable requirements of NEMA WC 71, WC 72, and WC 74.
2. Conductor Type:
 - a. 120- and 277-Volt Lighting, No. 10 AWG and Smaller: Solid copper.
 - b. 120-Volt Receptacle Circuits, No. 10 AWG and Smaller: Solid copper.
 - c. All Other Circuits: Stranded copper.
3. Insulation: Type THHN/THWN, except for sizes No. 6 and larger, with XHHW-2 insulation.

4. Flexible Cords and Cables:
 - a. Type SOW-A/50 with ethylene propylene rubber insulation in accordance with UL 62.
 - b. Conform to physical and minimum thickness requirements of NEMA WC 70.

B. 600-Volt Rated Cable:

1. General:
 - a. Type TC, meeting requirements of UL 1277, including Vertical Tray Flame Test at 20,000 Btu per hour, and NFPA 70, Article 340, or UL 13 meeting requirements of NFPA 70, Article 725.
 - b. Permanently and legibly marked with manufacturer's name, maximum working voltage for which cable was tested, type of cable, and UL listing mark.
 - c. Suitable for installation in open air, in cable trays, or conduit.
 - d. Minimum Temperature Rating: 90 degrees C dry locations, 75 degrees C wet locations.
 - e. Overall Outer Jacket: PVC, flame-retardant, sunlight- and oil-resistant.
2. Type 3, No. 16 AWG, Twisted, Shielded Pair, Instrumentation Cable: Single pair, designed for noise rejection for process control, computer, or data log applications meeting NEMA WC 55 requirements.
 - a. Outer Jacket: 45 mils nominal thickness.
 - b. Individual Pair Shield: 1.35 mils, double-faced aluminum/synthetic polymer overlapped to provide 100 percent coverage.
 - c. Dimension: 0.31-inch nominal outside diameter.
 - d. Conductors:
 - 1) Bare soft annealed copper, Class B, seven-strand concentric, meeting requirements of ASTM B8.
 - 2) 20 AWG, seven-strand tinned copper drain wire.
 - 3) Insulation: 15 mils nominal PVC.
 - 4) Jacket: 4 mils nominal nylon.
 - 5) Color Code: Pair conductors black and red.
 - e. Manufacturers: Okonite Co.
3. Type CAT 6, Unshielded Twisted Pair (UTP) Telephone and Data Cable:
 - a. Category 6 UTP, UL listed, and third party verified to comply with TIA/EIA 568 C Category 6 requirements.
 - b. Suitable for high speed network applications including gigabit ethernet and video. Cable shall be interoperable with other standards compliant products and shall be backward compatible with Category 5 and Category 5e.

- c. Provide four each individually twisted pair, 23 AWG conductors, with FEP insulation and blue PVC jacket.
- d. NFPA 70 Plenum (CMP) rated; comply with flammability plenum requirements of NFPA 70 and NFPA 262.
- e. Cable shall withstand a bend radius of 1 inch minimum at a temperature of minus 20 degrees C maximum without jacket or insulation cracking.
- f. Manufacturer: Belden.

C. Accessories:

- 1. Tape:
 - a. General Purpose, Flame Retardant: 7 mils, vinyl plastic, Scotch Brand 33, rated for 90 degrees C minimum, meeting requirements of UL 510.
 - b. Flame Retardant, Cold and Weather Resistant: 8.5 mils, vinyl plastic, Scotch Brand 88.
 - c. Arc and Fireproofing:
 - 1) 30 mils, elastomer.
 - 2) Manufacturers and Products:
 - a) 3M; Scotch Brand 77, with Scotch Brand 69 glass cloth tapebinder.
 - b) Plymount; Plyarc 53, with Plyglas 77 glass cloth tapebinder.
- 2. Identification Devices:
 - a. Sleeve-type, permanent, PVC, yellow or white, with legible machine-printed black markings.
 - b. Manufacturer and Products: Raychem; Type D-SCE or ZH-SCE.
- 3. Connectors and Terminations:
 - a. Nylon, Self-Insulated Crimp Connectors:
 - 1) Manufacturers and Products:
 - a) Thomas & Betts; Sta-Kon.
 - b) Burndy; Insulug.
 - c) ILSCO.
- 4. Self-Insulated, Freespring Wire Connector (Wire Nuts):
 - a. Plated steel, square wire springs.
 - b. UL Standard 486C.
 - c. Manufacturers and Products:
 - 1) Thomas & Betts.
 - 2) Ideal; Twister.
- 5. Cable Lugs:
 - a. In accordance with NEMA CC 1.
 - b. Rated 600 volts of same material as conductor metal.
 - c. Uninsulated Crimp Connectors and Terminators:
 - 1) Suitable for use with 75 degrees C wire at full NFPA 70, 75 degrees C ampacity.

- 2) Manufacturers and Products:
 - a) Thomas & Betts; Color-Keyed.
 - b) Burndy; Hydent.
 - c) ILSCO.
- d. Uninsulated, Bolted, Two-Way Connectors and Terminators:
 - 1) Manufacturers and Products:
 - a) Thomas & Betts; Locktite.
 - b) Burndy; Quiklug.
 - c) ILSCO.
- 6. Cable Ties:
 - a. Nylon, adjustable, self-locking, and reusable.
 - b. Manufacturer and Product: Thomas & Betts; TY-RAP.
- 7. Heat Shrinkable Insulation:
 - a. Thermally stabilized, crosslinked polyolefin.
 - b. Manufacturer and Product: Thomas & Betts; SHRINK-KON.

2.20 MOTORS

A. Three-Phase:

- 1. For multiple units of the same type of equipment, furnish identical motors and accessories of a single manufacturer.
- 2. Meet requirements of NEMA MG 1.
- 3. Provide motors for hazardous (classified) locations that conform to UL 674 and have an applied UL listing mark.
- 4. Motors shall be specifically designed for use and conditions intended, with a NEMA design letter classification to fit application.
- 5. Lifting lugs on motors weighing 100 pounds or more.
- 6. Operating Conditions: Maximum ambient temperature not greater than 40 degrees C.
- 7. Horsepower Rating: As designated in motor-driven equipment specifications. Brake horsepower of the driven equipment at any operating condition shall not exceed motor nameplate horsepower rating, excluding any service factor.
- 8. Service Factor: 1.15 minimum at rated ambient temperature, unless otherwise shown.
- 9. Voltage and Frequency Rating: 460V ac, 60 Hz, unless otherwise indicated in motor-driven equipment specifications.
- 10. Suitable for full voltage starting. 100 hp and larger also suitable for reduced voltage starting with 65 percent or 80 percent voltage tap settings on reduced inrush motor starters.
- 11. Efficiency and Power Factor: Provide premium efficiency units, except for under 1 hp, multispeed, or short-time rated motors, or motors driving gates, valves, elevators, cranes, trolleys, and hoists. Provide standard power factor.

12. Insulation Systems: Unless otherwise indicated in motor-driven equipment specifications, Class B or Class F at nameplate horsepower and designated operating conditions, except EXP motors that shall be Class B with Class B rise.
13. Enclosures:
 - a. Open drip-proof, unless specified otherwise in the motor-driven equipment specification. Provide screens over air openings. Enclosures shall conform to NEMA MG 1.
 - b. TEFC and TENV: Furnish with a drain hole with porous drain/weather plug.
 - c. Equipment Finish: Manufacturer's standard.
14. Winding Thermal Protection:
 - a. Thermostats:
 - 1) Bi-metal disk or rod type thermostats embedded in stator windings.
 - 2) Automatic reset contacts rated 120V ac, 5 amps minimum, opening on excessive temperature.
 - 3) Leads extending to separate terminal box for motors 100 hp and larger.
15. Nameplates: In accordance with NEMA MG1.
16. Multispeed: Meet requirements for speeds, number of windings, and load torque classification indicated in the motor-driven equipment specifications.
17. Inverter Duty Motor:
 - a. Motor supplied power by adjustable frequency drives shall be inverter duty-rated.
 - b. Motor shall meet all applicable requirements of NEMA MG 1, Section IV, Part 30 and Part 31.
 - c. Motor shall be suitable for operation over entire speed range indicated.
 - d. Provide forced ventilation where speed ratio is greater than published range for motor being installed. Provide and coordinate fan power supply and motor control requirements with associated drive.
 - e. Motor installed in Division 1 hazardous (classified) locations shall be identified as acceptable for variable speed when used in a Division 1 location.

B. Single-Phase:

1. Provide induction-type unit meeting NEMA MG 1 requirements and suitable for application and mounting with the driven load. Motor shall be 115/230V ac, 60 Hz. Provide integral thermal protection and manufacturer's standard insulation system.
2. Horsepower rating: As specified under motor-driven equipment specification.

3. Single-speed: Single-winding. Speed as specified under motor-driven equipment specification.
4. Two-speed: Two-winding; speeds as specified under motor-driven equipment specification.
5. Enclosure: Open drip-proof, unless otherwise noted.

C. Manufacturers:

1. General Electric.
2. Reliance Electric.
3. U.S. Electrical Motors.

D. Factory Testing:

1. Tests:
 - a. In accordance with IEEE 112 for polyphase motors and IEEE 114 for single-phase motors.
 - b. Provide routine (production) tests on all motors in accordance with NEMA MG 1. Test multispeed motors at all speeds.
 - c. For premium efficiency motors, test efficiency and power factor at 50 percent, 75 percent, and 100 percent of rated horsepower:
 - 1) In accordance with IEEE 112, Test Method B, and NEMA MG 1, Paragraph 12.54 and Paragraph 12.57.
 - 2) For smaller motors, furnish a copy of a certified motor efficiency test report for identical motor.
2. Test Report Forms:
 - a. Routine Tests: IEEE 112, Form A-1.
 - b. Efficiency and power factor by Test Method B, IEEE 112, Form A-2, and NEMA MG 1, Paragraph (table) 12.57.

2.21 GROUNDING

- A. Ground Rods: Provide copper-clad steel with minimum diameter of 5/8 inch, and length of 10 feet.
- B. Ground Conductors: As specified in Article Conductors and Cable.
- C. Connectors:
 1. Exothermic Weld Type:
 - a. Outdoor Weld: Suitable for exposure to elements or direct burial.
 - b. Indoor Weld: Use low-smoke, low-emission process.
 - c. Manufacturers:
 - 1) Erico Products, Inc.; Cadweld and Cadweld Exolon.
 - 2) Thermoweld.

2. Compression Type:
 - a. Compress-deforming type; wrought copper extrusion material.
 - b. Single indentation for conductors 6 AWG and smaller.
 - c. Double indentation with extended barrel for conductors 4 AWG and larger.
 - d. Single barrels prefilled with oxide-inhibiting and antiseizing compound.
 - e. Manufacturers:
 - 1) Burndy Corp.
 - 2) Thomas and Betts Co.
 - 3) ILSCO.
3. Mechanical Type:
 - a. Split-bolt, saddle, or cone screw type; copper alloy material.
 - b. Manufacturers:
 - 1) Burndy Corp.
 - 2) Thomas and Betts Co.

2.22 MODIFICATIONS TO EXISTING LOW VOLTAGE MOTOR CONTROL

A. General:

1. Make adjustments as necessary to wiring, conduit, disconnect devices, motor starters, branch circuit protection, and other affected material or equipment to accommodate motors and motor ratings actually provided.
2. Existing MCC is GE 8000 Line FO# M-221369. Work included new circuit breakers installed in existing Motor Control Center. New circuit breakers shall have minimum short circuit rating 65000 amps rms symmetrical.

2.23 LUMINAIRES AND ACCESSORIES

- ### A. Specific requirements relating to fixture type, lamp type, and mounting are provided in the Drawings.

PART 3 EXECUTION

3.01 GENERAL

- A. Install materials and equipment in accordance with manufacturer's instructions and recommendations.
- B. Work shall comply with all applicable provisions of NECA 1.
- C. Install materials and equipment in hazardous areas in a manner acceptable to regulatory authority having jurisdiction for the class, division, and group of hazardous areas shown.
- D. Electrical Drawings show general locations of equipment, devices, and raceway, unless specifically dimensioned.

3.02 DEMOLITION

A. General Demolition:

1. Where shown, de-energize and disconnect nonelectrical equipment for removal by others.
2. Where shown, de-energize, disconnect, and remove electrical equipment.
3. Remove affected circuits and raceways back to serving panelboard or control panel. Where affected circuits are consolidated with others, remove raceways back to first shared conduit or box. Where underground or embedded raceways are to be abandoned, remove raceway to 1 inch below surface of structure or 12 inches belowgrade and restore existing surface.

3.03 PROTECTION FOLLOWING INSTALLATION

- A. Protect materials and equipment from corrosion, physical damage, and effects of moisture on insulation.
- B. Cap conduit runs during construction with manufactured seals.
- C. Close openings in boxes or equipment during construction.
- D. Energize space heaters furnished with equipment.

3.04 OUTLET AND DEVICE BOXES

- A. Install suitable for conditions encountered at each outlet or device in wiring or raceway system, sized to meet NFPA 70 requirements.
- B. Size:
 1. Depth: Minimum 2 inches, unless otherwise required by structural conditions. Box extensions not permitted.
 - a. Hollow Masonry Construction: Install with sufficient depth such that conduit knockouts or hubs are in masonry void space.
 2. Ceiling Outlet: Minimum 4-inch octagonal sheet steel device box, unless otherwise required for installed fixture.
 3. Switch and Receptacle: Minimum 2-inch by 4-inch sheet steel device box.
- C. Locations:
 1. Drawing locations are approximate.
 2. To avoid interference with mechanical equipment or structural features, relocate outlets as directed by Engineer.
 3. Light Switch: Install on lock side of doors.

D. Mounting Height:

1. General:
 - a. Dimensions given to centerline of box.
 - b. Where specified heights do not suit building construction or finish, mount as directed by Engineer.
2. Switches: 48 inches above floor.
3. Receptacles:
 - a. General Indoor Areas: 15 inches above floor.
 - b. General Indoor Areas (Counter Tops): Install device plate bottom or side flush with top of splashback, or 6 inches above counter tops without splashback.
 - c. Outdoor, All Areas: 24 inches above finished grade.

E. Install plumb and level.

F. Flush Mounted:

1. Install with concealed conduit.
2. Install proper type extension rings or plaster covers to make edges of boxes flush with finished surface.

G. Support boxes independently of conduit by attachment to building structure or structural member.

1. Outdoor Locations: Cast metal.
2. Indoor Dry non-corrosive Locations:
 - a. Exposed Rigid Conduit: Cast metal.
3. Indoor Wet or Corrosive Locations: PVC-coated cast metal with matching cover.

H. Box Type, Corrosive Locations (PVC-Coated rigid Galvanized Steel Raceway System): PVC-coated cast metal with matching cover.

3.05 JUNCTION AND PULL BOXES

- A. Install where shown and where necessary to terminate, tap-off, or redirect multiple conduit runs.
- B. Install pull boxes where necessary in raceway system to facilitate conductor installation.
- C. Install in conduit runs at least every 150 feet or after the equivalent of three right-angle bends.
- D. Use outlet boxes as junction and pull boxes wherever possible and allowed by applicable codes.

- E. Use conduit bodies as junction and pull boxes where no splices are required and their use is allowed by applicable codes.
- F. Installed boxes shall be accessible.
- G. Do not install on finished surfaces.
- H. Install plumb and level.
- I. Support boxes independently of conduit by attachment to building structure or structural member.
- J. At or Belowgrade:
 - 1. Install boxes for belowgrade conduit flush with finished grade in locations outside of paved areas, roadways, or walkways.
 - 2. If adjacent structure is available, box may be mounted on structure surface just above finished grade in accessible but unobtrusive location.
 - 3. Obtain Engineer's written acceptance prior to installation in paved areas, roadways, or walkways.
 - 4. Use boxes and covers suitable to support anticipated weights.
- K. Mounting Hardware: Stainless steel.
- L. Location/Type:
 - 1. Indoor, Dry: NEMA 250, Type 1.
 - 2. Indoor and Outdoor, Wet or Corrosive: NEMA 250, Type 4X, stainless steel.
 - 3. Underground Conduit: Concrete.
 - 4. Corrosive: NEMA 250, Type 4X, stainless steel.
- M. Install Drain/breather fittings in NEMA 250, Type 4 and Type 4X enclosures.

3.06 PRECAST HANDHOLES

- A. Excavate, shore, brace, backfill, and final grade in accordance with Section 31 23 16, Excavation, and Section 31 23 23.15, Trench Backfill.
- B. Do not install until final raceway grading has been determined.
- C. Install such that raceways enter at nearly right angles and as near as possible to one end of wall, unless otherwise shown.

3.07 WIRING DEVICES

A. Switches:

1. Mounting Height: See Article Outlet and Device Boxes.
2. Install with switch operation in vertical position.
3. Install single-pole, two-way switches such that toggle is in up position when switch is on.

B. Receptacles:

1. Ground receptacles to boxes with grounding wire only.
2. Weatherproof Receptacles:
 - a. Install in cast metal box.
 - b. Install such that hinge for protective cover is above receptacle opening.
3. Ground Fault Interrupter: Install feed-through model at locations where ground fault protection is specified for “downstream” conventional receptacles.

3.08 DEVICE PLATES

A. Securely fasten to wiring device; ensure a tight fit to box.

B. Flush Mounted: Install with all four edges in continuous contact with finished wall surfaces without use of mats or similar materials. Plaster fillings will not be acceptable.

C. Surface Mounted: Plate shall not extend beyond sides of box, unless plates have no sharp corners or edges.

D. Install with alignment tolerance to box of 1/16 inch.

E. Types (Unless Otherwise Shown):

1. Outdoor: Weatherproof.
2. Indoor:
 - a. Flush Mounted Boxes: Metal.
 - b. Surface Mounted, Metal Boxes: Cast.

3.09 PANELBOARDS

A. Install securely, plumb, in-line and square with walls.

B. Install top of cabinet 6 feet above floor, unless otherwise shown.

C. Provide typewritten circuit directory for each panelboard.

D. Cabinet Location/Type:

1. Indoor Dry: NEMA 250, Type 1.
2. Wet or Outdoor: NEMA 250, Type 3R, Outdoor.
3. Industrial Use in Areas Not Otherwise Classified: NEMA 250, Type 12, unless otherwise shown.

3.10 CIRCUIT BREAKERS AND SWITCHES

A. Location and Enclosure Type:

1. Wet or Outdoor: NEMA 250, Type 4X.
2. Corrosive: NEMA 250, Type 4X.
3. Wet and Corrosive: NEMA 250, Type 4X.
4. Indoor Dry, Industrial Use: NEMA 250, Type 12.
5. Indoor Dry, General Purpose: NEMA 250, Type 1.
6. Where Denoted WP: NEMA 250, Type 3R.

3.11 SWITCH, MOTOR RATED

- A. Install with switch operation in vertical position such that toggle is in up position when ON.
- B. Install within sight of motor when used as a disconnect switch.
- C. Mounting Height: See Article Outlet and Device Boxes.
- D. Enclosure Type:
 1. General Purpose: See Articles Outlet and Device Boxes and Device Plates.
 2. Explosion-proof: See product specification.

3.12 TERMINAL BLOCKS

- A. Install for termination of control circuits entering or leaving equipment and local control panels.

3.13 DRY TYPE POWER TRANSFORMERS (0- TO 600-VOLT PRIMARY)

- A. Load external vibration isolator such that no direct transformer unit metal is in direct contact with mounting surface.
- B. Provide moisture-proof flexible conduit for electrical connections.
- C. Connect voltage taps to achieve (approximately) rated output voltage under normal plant load conditions.
- D. Provide wall brackets where required.

3.14 SUPPORT AND FRAMING CHANNELS

- A. Install where required for mounting and supporting electrical equipment and raceway systems.
- B. Channel Type:
 - 1. Interior, Dry Noncorrosive Locations: Carbon steel.
 - 2. Interior, Wet or Dry Corrosive Locations: Type 316 stainless steel.
 - 3. Outdoor, Corrosive Locations: Type 316 stainless steel.
- C. Paint carbon steel channel cut ends prior to installation with zinc-rich primer.

3.15 NAMEPLATES

- A. Provide identifying nameplate on all equipment.

3.16 SURGE PROTECTIVE DEVICE

- A. Install in accordance with manufacturer's instructions, including lead length, overcurrent protection, and grounding.

3.17 CONDUIT AND FITTINGS

- A. General:
 - 1. Crushed or deformed raceways not permitted.
 - 2. Maintain raceway entirely free of obstructions and moisture.
 - 3. Immediately after installation, plug or cap raceway ends with watertight and dust-tight seals until time for pulling in conductors.
 - 4. Sealing Fittings: Provide drain seal in vertical raceways where condensate may collect above sealing fitting.
 - 5. Avoid moisture traps where possible. When unavoidable in exposed conduit runs, provide junction box and drain fitting at conduit low point.
 - 6. Group raceways installed in same area.
 - 7. Follow structural surface contours when installing exposed raceways. Avoid obstruction of passageways.
 - 8. Run exposed raceways parallel or perpendicular to walls, structural members, or intersections of vertical planes.
 - 9. Block Walls: Do not install raceways in same horizontal course with reinforcing steel.
 - 10. Install watertight fittings in outdoor, underground, or wet locations.
 - 11. Paint threads and cut ends, before assembly of fittings, galvanized conduit, or PVC-coated galvanized conduit installed in exposed or damp locations with zinc-rich paint or liquid galvanizing compound.
 - 12. Metal conduit to be reamed, burrs removed, and cleaned before installation of conductors, wires, or cables.

13. Do not install raceways in concrete equipment pads, foundations, or beams.
14. Horizontal raceways installed under floor slabs shall lie completely under slab, with no part embedded within slab.
15. Install concealed, embedded, and buried raceways so that they emerge at right angles to surface and have no curved portion exposed.
16. Install conduits for fiber optic cables, telephone cables, and Category 5 data cables in strict conformance with the requirements of EIA/TIA 569.

B. Installation in Cast-in-Place Structural Concrete:

1. Minimum cover 2 inches, including all fittings.
2. Conduit placement shall not require changes in reinforcing steel location or configuration.
3. Provide nonmetallic support during placement of concrete to ensure raceways remain in position.
4. Conduit larger than 1 inch shall not be embedded in concrete slabs, walls, foundations, columns or beams, unless approved by Engineer.
5. Slabs and Walls:
 - a. Trade size of conduit not to exceed one-fourth of the slab or wall thickness.
 - b. Install within middle two-fourths of slab or wall.
 - c. Separate conduit less than 2-inch trade size by a minimum ten times conduit trade size, center-to-center, unless otherwise shown.
 - d. Separate conduit 2 inches and greater trade size by a minimum eight times conduit trade size, center-to-center, unless otherwise shown.
 - e. Cross conduit at an angle greater than 45 degrees, with minimum separation of 1 inch.
 - f. Separate conduit by a minimum six times the outside dimension of expansion and deflection fittings at expansion joints.
 - g. Conduit shall not be installed below the maximum water surface elevation in walls of water holding structures.
6. Columns and Beams:
 - a. Trade size of conduit not to exceed one-fourth of beam thickness.
 - b. Conduit cross-sectional area not to exceed 4 percent of beam or column cross section.

C. Conduit Application:

1. Diameter: Minimum 3/4 inch.
2. Outdoor, Exposed: PVC-coated rigid galvanized steel.
3. Indoor, Dry and Noncorrosive, Exposed:
 - a. Rigid galvanized steel.
 - b. PVC-coated rigid galvanized steel.
4. Direct Earth Burial: PVC-coated rigid galvanized steel.

5. Under Slabs-On-Grade: PVC-coated rigid galvanized steel.
6. Corrosive Areas: PVC-coated rigid galvanized steel.

D. Connections:

1. For motors-, wall-, or ceiling-mounted fans and unit heaters, dry type transformers, electrically operated valves, instrumentation, and other equipment where flexible connection is required to minimize vibration:
 - a. General: Flexible metal, liquid-tight conduit.
 - b. Wet or Corrosive Areas: Flexible metal liquid-tight.
 - c. Length: 18 inches minimum, 60 inches maximum, sufficient to allow movement or adjustment of equipment.
2. Lighting Fixtures in Dry Areas: Flexible metal, liquid-tight conduit.
3. Outdoor areas, process areas exposed to moisture, and areas required to be oiltight and dust-tight: Flexible metal, liquid-tight conduit.
4. Transition From Underground or Concrete Embedded to Exposed: PVC-coated rigid steel conduit.
5. Under Equipment Mounting Pads: PVC-coated rigid steel conduit.

E. Penetrations:

1. Make at right angles, unless otherwise shown.
2. Notching or penetration of structural members, including footings and beams, not permitted.
3. Fire-Rated Walls, Floors, or Ceilings: Firestop openings around penetrations to maintain fire-resistance rating using fire penetration seal as specified in Section 07 92 00, Joint Sealants.
4. Concrete Walls, Floors, or Ceilings (Aboveground): Provide nonshrink grout dry-pack.
5. Entering Structures:
 - a. General: Seal raceway at the first box or outlet with oakum or expandable plastic compound to prevent the entrance of gases or liquids from one area to another.
 - b. Corrosive-Sensitive Areas:
 - 1) Seal all conduit passing through chlorine ammonia room walls.
 - 2) Seal conduit entering equipment panelboards and field panels containing electronic equipment.
 - 3) Seal penetration with Type 5 sealant, as specified in Section 07 92 00, Joint Sealants.
 - c. Existing or Precast Wall (Underground): Core drill wall and install watertight entrance seal device.
 - d. Handholes:
 - 1) Metallic Raceways: Provide insulated grounding bushings.
 - 2) Nonmetallic Raceways: Provide bell ends flush with wall.

F. Support:

1. Support from structural members only, at intervals not exceeding NFPA 70 requirements, and in any case not exceeding 10 feet. Do not support from piping, pipe supports, or other raceways.
2. Multiple Adjacent Raceways: Provide ceiling trapeze. For trapeze-supported conduit, allow 20 percent extra space for future conduit.
3. Application/Type of Conduit Strap:
 - a. Steel Conduit: Zinc-coated steel, pregalvanized steel, or malleable iron.
 - b. PVC-Coated Rigid Steel Conduit: PVC-coated metal.
 - c. Nonmetallic Conduit: Nonmetallic or PVC-coated metal.
4. Provide and attach wall brackets, strap hangers, or ceiling trapeze as follows:
 - a. Wood: Wood screws.
 - b. Hollow Masonry Units: Toggle bolts.
 - c. Concrete or Brick: Expansion shields, or threaded studs driven in by powder charge, with lock washers and nuts.
 - d. Steelwork: Machine screws.
 - e. Location/Type of Hardware:
 - 1) Dry, Noncorrosive Areas: Galvanized.
 - 2) Wet, Noncorrosive Areas: Stainless steel.
 - 3) Corrosive Areas: Stainless steel.

G. Bends:

1. Install concealed raceways with a minimum of bends in the shortest practical distance.
2. Make bends and offsets of longest practical radius. Bends in conduits and ducts being installed for fiber optic cables shall be not less than 20 times cable diameter, 15 inches minimum.
3. Install with symmetrical bends or cast metal fittings.
4. Avoid field-made bends and offsets, but where necessary, make with acceptable hickey or bending machine. Do not heat metal raceways to facilitate bending.
5. Make bends in parallel or banked runs from same center or centerline with same radius so that bends are parallel.
6. Factory elbows may be installed in parallel or banked raceways if there is change in plane of run and raceways are same size.
7. PVC Conduit:
 - a. Bends 30 Degrees and Larger: Provide factory-made elbows.
 - b. 90-Degree Bends: Provide rigid steel elbows, PVC coated where direct buried.
 - c. Use manufacturer's recommended method for forming smaller bends.

8. Flexible Conduit: Do not make bends that exceed allowable conductor bending radius of cable to be installed or that significantly restricts conduit flexibility.
- H. Expansion and Deflection Fittings: Provide on all raceways at structural expansion joints and in long tangential runs.
- I. PVC Conduit:
1. Solvent Welding:
 - a. Provide manufacturer recommended solvent; apply to all joints.
 - b. Install such that joint is watertight.
 2. Adapters:
 - a. PVC to Metallic Fittings: PVC terminal type.
 - b. PVC to Rigid Metal Conduit or IMC: PVC female adapter.
 3. Belled-End Conduit: Bevel the unbelled end of the joint prior to joining.
- J. PVC-Coated Rigid Steel Conduit:
1. Install in accordance with manufacturer's instructions.
 2. All tools and equipment used in the cutting, bending, threading, and installation of PVC-coated rigid steel conduit shall be designed to limit damage to the PVC coating.
 3. Provide PVC boot to cover all exposed threading.
- K. Termination at Enclosures:
1. Cast Metal Enclosure: Provide manufacturer's premolded insulating sleeve inside metallic conduit terminating in threaded hubs.
 2. Nonmetallic, Cabinets, and Enclosures: Terminate conduit in threaded conduit hubs, maintaining enclosure integrity.
 3. Sheet Metal Boxes, Cabinets, and Enclosures:
 - a. Rigid Galvanized Conduit:
 - 1) Provide one lock nut each on inside and outside of enclosure.
 - 2) Install grounding bushing.
 - 3) Provide bonding jumper from grounding bushing to equipment ground bus or ground pad; if neither ground bus nor pad exists, connect jumper to lag bolt attached to metal enclosure.
 - 4) Install insulated bushing on ends of conduit where grounding is not required.
 - 5) Provide insulated throat when conduit terminates in sheet metal boxes having threaded hubs.
 - 6) Utilize sealing locknuts or threaded hubs on outside of NEMA 3R and NEMA 12 enclosures.
 - 7) Terminate conduits with threaded conduit hubs at NEMA 4 and 4X boxes and enclosures.

- b. Flexible Metal Conduit: Provide two-screw type, insulated, malleable iron connectors.
- c. PVC-Coated Rigid Galvanized Steel Conduit: Provide PVC-coated, liquid-tight, metallic connector.
- d. PVC Schedule 40 Conduit: Provide PVC terminal adapter with locknut.
- 4. Free-Standing Enclosures:
 - a. Terminate metal conduit entering bottom with grounding bushing; provide a grounding jumper extending to equipment ground bus or grounding pad.
 - b. Terminate PVC conduit entering bottom with bell end fittings.

L. Underground Raceways:

- 1. Grade: Maintain minimum grade of 4 inches in 100 feet, either from one manhole, handhole, or pull box to the next, or from a high point between them, depending on surface contour.
- 2. Cover: Maintain minimum 2-foot cover above conduit, unless otherwise shown.
- 3. Make routing changes as necessary to avoid obstructions or conflicts.
- 4. Couplings: In multiple conduit runs, stagger so couplings in adjacent runs are not in same transverse line.
- 5. Union type fittings not permitted.
- 6. Spacers:
 - a. Provide preformed, nonmetallic spacers, designed for such purpose, to secure and separate parallel conduit runs in a trench.
 - b. Install at intervals not greater than that specified in NFPA 70 for support of the type conduit used, but in no case greater than 10 feet.
- 7. Support conduit so as to prevent bending or displacement during backfilling.
- 8. Installation with Other Piping Systems:
 - a. Crossings: Maintain minimum 12-inch vertical separation.
 - b. Parallel Runs: Maintain minimum 12-inch separation.
 - c. Installation over valves or couplings not permitted.
- 9. Metallic Raceway Coating: Along entire length, coat with raceway coating.
- 10. Provide expansion fittings that allow minimum of 4 inches of movement in vertical conduit runs from underground where exposed conduit will be fastened to or will enter building or structure.
- 11. Provide deflectional/expansion fittings in conduit runs that exit building or structure belowgrade. Conduit from building wall to fitting shall be PVC-coated rigid steel.
- 12. Backfill: As specified in Section 31 23 23.15, Trench Backfill.

M. Empty Raceways:

1. Provide permanent, removable cap over each end.
2. Provide PVC plug with pull tab for underground raceways with end bells.
3. Provide nylon pull cord.
4. Identify, as specified in Article Identification Devices, with waterproof tags attached to pull cord at each end, and at intermediate pull point.

N. Identification Devices:

1. Raceway Tags:
 - a. Identify origin and destination.
 - b. Install at each terminus, near midpoint, and at minimum intervals of every 50 feet of exposed raceway, whether in ceiling space or surface mounted.
 - c. Provide nylon strap for attachment.
2. Warning Tape: Install approximately 12 inches above underground or concrete-encased raceways. Align parallel to, and within 12 inches of, centerline of runs.

O. Raceway Band: Install wherever metallic conduit emerges from concrete slabs. Not required with PVC-coated RGS conduit. Center band at slab surface and install according to manufacturer's instructions.

1. Slip-on Type: Clean conduit surface at installation location. Cut tubing to 4-inch minimum lengths and slip onto raceway prior to slab placement and termination of conduit. Heat-shrink onto conduit.
2. Wrap-around Type: Use where slip-on access to conduit is not possible. Clean conduit surface at installation location. Apply primer. Apply wraps to provide two layers of tape. Neatly finish tape end to prevent unraveling.

3.18 METAL WIREWAYS

- A. Install in accordance with manufacturer's instructions.
- B. Locate with cover on accessible vertical face of wireway, unless otherwise shown.

3.19 CONDUCTORS AND CABLES

- A. Conductor storage, handling, and installation shall be in accordance with manufacturer's recommendations.
- B. Do not exceed manufacturer's recommendations for maximum pulling tensions and minimum bending radii.

- C. Conduit system shall be complete prior to drawing conductors. Lubricate prior to pulling into conduit. Lubrication type shall be as approved by conductor manufacturer.
- D. Terminate all conductors and cables, unless otherwise shown.
- E. Do not splice conductors, unless specifically indicated or approved by Engineer.
- F. Bundling: Where single conductors and cables in manholes, handholes, vaults, cable trays, and other indicated locations are not wrapped together by some other means, bundle conductors from each conduit throughout their exposed length with cable ties placed at intervals not exceeding 12 inches.
- G. Wiring within Equipment and Local Control Panels: Remove surplus wire, dress, bundle, and secure.
- H. Power Conductor Color Coding:
 - 1. No. 6 AWG and Larger: Apply general purpose, flame retardant tape at each end, and at accessible locations wrapped at least six full overlapping turns, covering an area 1-1/2 inches to 2 inches wide.
 - 2. No. 8 AWG and Smaller: Provide colored conductors.
 - 3. Colors:
 - a. Neutral Wire: White.
 - b. Live Wires, 120/240-Volt, Single-Phase System: Black, red.
 - c. Live Wires, 120/208-Volt, Three-Phase System: Black, red, or blue.
 - d. Live Wires, 277/480-Volt, Three-Phase System: Brown, orange, or yellow.
 - e. Ground Wire: Green.
- I. Circuit Identification:
 - 1. Assign circuit name based on device or equipment at load end of circuit. Where this would result in same name being assigned to more than one circuit, add number or letter to each otherwise identical circuit name to make it unique.
 - 2. Method: Identify with sleeves. Taped-on markers or tags relying on adhesives not permitted.
- J. Connections and Terminations:
 - 1. Install wire nuts only on solid conductors.
 - 2. Install nylon self-insulated crimp connectors and terminators for instrumentation and control circuit conductors.

3. Tape insulate all uninsulated connections.
4. Install crimp connectors and compression lugs with tools approved by connector manufacturer.

3.20 GROUNDING

- A. Grounding shall be in compliance with NFPA 70 and as shown.
- B. Ground electrical service neutral at service entrance equipment to supplementary grounding electrodes.
- C. Ground each separately derived system neutral to nearest effectively grounded building structural steel member or separate grounding electrode.
- D. Bond together system neutrals, service equipment enclosures, exposed noncurrent-carrying metal parts of electrical equipment, metal raceways, ground conductor in raceways and cables, receptacle ground connections, and metal piping systems.
- E. Shielded Instrumentation Cables:
 1. Ground shield to ground bus at power supply for analog signal.
 2. Expose shield minimum 1 inch at termination to field instrument and apply heat shrink tube.
 3. Do not ground instrumentation cable shield at more than one point.
- F. Equipment Grounding Conductors: Provide in all conduits containing power conductors and control circuits above 50 volts.
- G. Ground Rods: Install full length with conductor connection at upper end. Install one ground rod in each handhole.

3.21 LOW VOLTAGE MOTOR CONTROL

- A. Install equipment in accordance with NEMA ICS 2.3 and manufacturer's instructions and recommendations.
- B. Field adjust trip settings of motor starter magnetic-trip-only circuit breakers. Adjust to approximately 11 times motor rated current.
- C. Select and install overload relay heaters or adjust electronic overload protection after the actual nameplate full-load current rating of motor has been determined.

3.22 LUMINAIRES AND ACCESSORIES

- A. Install in accordance with manufacturer's recommendations.
- B. Install plumb and level at mounting heights shown.
- C. Provide proper hangers, pendants, and canopies as necessary for complete installation.
- D. Install symmetrically with suspended ceiling pattern in finished areas.
- E. Unfinished Areas: Locate luminaires to avoid conflict with other building systems or blockage of luminaire light output.
- F. Building Exterior: Provide flush-mounted back box and concealed conduit, unless otherwise shown.

3.23 FIELD QUALITY CONTROL

- A. Tests shall be performed in accordance with the requirements of Section 01 91 14, Equipment Testing and Facility Startup.
- B. General:
 - 1. Test equipment shall have an operating accuracy equal to, or greater than, requirements established by NETA ATS.
 - 2. Test instrument calibration shall be in accordance with NETA ATS.
 - 3. Perform inspection and electrical tests after equipment has been installed.
 - 4. Perform tests with apparatus de-energized whenever feasible.
 - 5. Inspection and electrical tests on energized equipment are to be:
 - a. Scheduled with Engineer prior to de-energization.
 - b. Minimized to avoid extended period of interruption to the operating plant equipment.
- C. Tests and inspection shall establish that:
 - 1. Electrical equipment is operational within industry and manufacturer's tolerances.
 - 2. Installation operates properly.
 - 3. Equipment is suitable for energization.
 - 4. Installation conforms to requirements of Contract Documents and NFPA 70.
- D. Perform inspection and testing in accordance with NETA ATS, industry standards, and manufacturer's recommendations.

- E. Adjust mechanisms and moving parts for free mechanical movement.
- F. Adjust adjustable relays and sensors to correspond to operating conditions, or as recommended by manufacturer.
- G. Verify nameplate data for conformance to Contract Documents.
- H. Realign equipment not properly aligned and correct unlevelness.
- I. Properly anchor electrical equipment found to be inadequately anchored.
- J. Tighten accessible bolted connections, including wiring connections, with calibrated torque wrench to manufacturer's recommendations, or as otherwise specified.
- K. Clean contaminated surfaces with cleaning solvents as recommended by manufacturer.
- L. Provide proper lubrication of applicable moving parts.
- M. Investigate and repair or replace:
 - 1. Electrical items that fail tests.
 - 2. Active components not operating in accordance with manufacturer's instructions.
 - 3. Damaged electrical equipment.
- N. Electrical Enclosures:
 - 1. Remove foreign material and moisture from enclosure interior.
 - 2. Vacuum and wipe clean enclosure interior.
 - 3. Remove corrosion found on metal surfaces.
 - 4. Repair or replace, as determined by Engineer, door and panel sections having damaged surfaces.
 - 5. Replace missing or damaged hardware.
- O. Provide certified test report(s) documenting the successful completion of specified testing. Include field test measurement data.
- P. Test the following equipment and materials:
 - 1. Conductors: Insulation resistance, No. 4 and larger only.
 - 2. Panelboards, switches, and circuit breakers.
 - 3. Motor controls.
 - 4. Grounding electrodes.
 - 5. Motors.

Q. Controls:

1. Test control and signal wiring for proper termination and function.
2. Test local control panels and other control devices for proper terminations, configuration and settings, and functions.
3. Demonstrate control, monitoring, and indication functions in presence of Owner and Engineer.

R. Balance electrical load between phases on panelboards after installation.

S. Equipment Line Current: Check line current in each phase for each piece of equipment.

END OF SECTION

SECTION 31 23 13 SUBGRADE PREPARATION

PART 1 GENERAL

1.01 REFERENCES

- A. The following is a list of standards which may be referenced in this section:
 - 1. ASTM International (ASTM):
 - a. D698, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lb/ft³ (600 kN-m/m³)).
 - b. D1557, Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft³ (2,700 kN-m/m³)).

1.02 DEFINITIONS

- A. Optimum Moisture Content: As defined in Section 31 23 23, Fill and Backfill.
- B. Prepared Ground Surface: Ground surface after completion of clearing and grubbing, scalping of sod, stripping of topsoil, excavation to grade, and scarification and compaction of subgrade.
- C. Relative Compaction: As defined in Section 31 23 23, Fill and Backfill.
- D. Relative Density: As defined in Section 31 23 23, Fill and Backfill.
- E. Subgrade: Layer of existing soil after completion of clearing, grubbing, scalping of topsoil prior to placement of fill, roadway structure or base for floor slab.
- F. Proof-Rolling: Testing of subgrade by compactive effort to identify areas that will not support the future loading without excessive settlement.

1.03 SEQUENCING AND SCHEDULING

- A. Complete applicable Work specified in Section 31 23 16, Excavation, prior to subgrade preparation.

1.04 QUALITY ASSURANCE

- A. Notify Engineer when subgrade is ready for compaction or proof-rolling or whenever compaction or proof-rolling is resumed after a period of extended inactivity.

1.05 ENVIRONMENTAL REQUIREMENTS

- A. Prepare subgrade when unfrozen and free of ice and snow.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 GENERAL

- A. Keep subgrade free of water, debris, and foreign matter during compaction or proof-rolling.
- B. Bring subgrade to proper grade and cross-section and uniformly compact surface.
- C. Do not use sections of prepared ground surface as haul roads. Protect prepared subgrade from traffic.
- D. Maintain prepared ground surface in finished condition until next course is placed.

3.02 COMPACTION

- A. Under Earthfill: Three passes with three-wheeled power roller weighing approximately 10 tons.
- B. Under Earthfill: Compact upper 6 inches to minimum of 100 percent relative compaction as determined in accordance with ASTM D1557, Method 95 percent relative density.
- C. Under Pavement Structure, Floor Slabs On Grade, or Granular Fill Under Structures: Three passes with a loaded dump truck or similar heavy-wheeled vehicle.
- D. Under Pavement Structure, Floor Slabs On Grade, or Granular Fill Under Structures: Compact the upper 6 inches to minimum of 100 percent relative compaction as determined in accordance with ASTM D1557, Method 95 percent relative density.

3.03 MOISTURE CONDITIONING

- A. Dry Subgrade: Add water, then mix to make moisture content uniform throughout.
- B. Wet Subgrade: Aerate material by blading, discing, harrowing, or other methods, to hasten drying process.

3.04 TESTING

- A. Proof-roll subgrade with equipment specified in Article Compaction to detect soft or loose subgrade or unsuitable material, as determined by Engineer.
- B. Measure the in-place density of the prepared subgrade using ASTM D1556 or D6938.
 - 1. Testing frequency: One test per 2,000 square feet of prepared subgrade, with a minimum of 1 test per proposed structure, slab-on-grade, mat foundations, or spread footings.
 - 2. Acceptance Criteria: Subgrade shall be within 2 percent of the laboratory maximum dry density and 2 percent of the optimum moisture content as determined by ASTM D698.

3.05 CORRECTION

- A. Soft or Loose Subgrade:
 - 1. Adjust moisture content and recompact, or
 - 2. Over excavate as specified in Section 31 23 16, Excavation, and replace with suitable material from the excavation, as specified in Section 31 23 23, Fill and Backfill.
- B. Unsuitable Material: Over excavate as specified in Section 31 23 16, Excavation, and replace with suitable material from the excavation, as specified in Section 31 23 23, Fill and Backfill.

END OF SECTION

SECTION 31 23 16 EXCAVATION

PART 1 GENERAL

1.01 DEFINITIONS

- A. Common Excavation: Removal of material not classified as rock excavation.

1.02 QUALITY ASSURANCE

- A. Provide adequate survey control to avoid unauthorized overexcavation.

1.03 WEATHER LIMITATIONS

- A. Material excavated when frozen or when air temperature is less than 32 degrees F shall not be used as fill or backfill until material completely thaws.
- B. Material excavated during inclement weather shall not be used as fill or backfill until after material drains and dries sufficiently for proper compaction.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 GENERAL

- A. Excavate to lines, grades, and dimensions shown and as necessary to accomplish Work. Excavate to within tolerance of plus or minus 0.1 foot, except where dimensions or grades are shown or specified as maximum or minimum. Allow for forms, working space, granular base, topsoil, and similar items, wherever applicable. Trim to neat lines where concrete is to be deposited against earth.
- B. Do not overexcavate without written authorization of Engineer.
- C. Remove or protect obstructions as shown and as specified in Section 01 50 00, Temporary Facilities and Controls, Article Protection of Work and Property.
- D. Use of explosives shall not be used.

3.02 UNCLASSIFIED EXCAVATION

- A. Excavation is unclassified. Complete all excavation regardless of the type, nature, or condition of the materials encountered.

3.03 CLASSIFIED EXCAVATION

- A. Excavation is classified; see Article Definitions for classifications. Notify Engineer whenever rock is encountered.
- B. In event of disputed quantities, excavate additional correlation trenches to apparent rock as considered necessary by Engineer to resolve dispute. Engineer reserves right to stop predrilling and blasting if, in Engineer's opinion, experience indicates that accurate determination of rock quantities is not possible by this method.

3.04 TRENCH WIDTH

- A. Minimum Width of Trenches:
 - 1. Single Pipes, Conduits, Direct-Buried Cables, and Duct Banks:
 - a. Less than 4-inch Outside Diameter or Width: 18 inches.
 - b. Greater than 4-inch Outside Diameter or Width: 18 inches greater than outside diameter or width of pipe, conduit, direct-buried cable, or duct bank.
 - 2. Multiple Pipes, Conduits, Cables, or Duct Banks in Single Trench: 18 inches greater than aggregate width of pipes, conduits, cables, duct banks, plus space between.
 - 3. Increase trench widths by thicknesses of sheeting.
- B. Maximum Trench Width: Unlimited, unless otherwise shown or specified, or unless excess width will cause damage to existing facilities, adjacent property, or completed Work.

3.05 PIPE BEDDING GROOVES FOR NONPERFORATED DRAIN LINES

- A. Semicircular, trapezoidal, or 90-degree-V.
- B. Excavated or plowed into trench bottom. Forming groove by compaction will not be acceptable.

3.06 EMBANKMENT AND CUT SLOPES

- A. Shape, trim, and finish cut slopes to conform with lines, grades, and cross-sections shown, with proper allowance for topsoil or slope protection, where shown.

- B. Remove stones and rock that exceed 3-inch diameter and that are loose and may roll down slope. Remove exposed roots from cut slopes.
- C. Round tops of cut slopes in soil to not less than a 6-foot radius, provided such rounding does not extend offsite or outside easements and rights-of-way, or adversely impacts existing facilities, adjacent property, or completed Work.

3.07 STOCKPILING EXCAVATED MATERIAL

- A. Stockpile excavated material that is suitable for use as fill or backfill until material is needed.
- B. Post signs indicating proposed use of material stockpiled. Post signs that are readable from all directions of approach to each stockpile. Signs should be clearly worded and readable by equipment operators from their normal seated position.
- C. Confine stockpiles to within easements, rights-of-way, and approved work areas. Do not obstruct roads or streets.
- D. Do not stockpile excavated material adjacent to trenches and other excavations, unless excavation side slopes and excavation support systems are designed, constructed, and maintained for stockpile loads.
- E. Do not stockpile excavated materials near or over existing facilities, adjacent property, or completed Work, if weight of stockpiled material could induce excessive settlement.

3.08 DISPOSAL OF SPOIL

- A. Dispose of excavated materials, which are unsuitable or exceed quantity needed for fill or backfill, offsite.

END OF SECTION

SECTION 31 23 23 FILL AND BACKFILL

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. ASTM International (ASTM):
 - a. C117, Standard Test Method for Materials Finer Than 75-Micrometers (No. 200) Sieve in Mineral Aggregates by Washing.
 - b. C136, Standard Method for Sieve Analysis of Fine and Coarse Aggregates.
 - c. D75, Standard Practice for Sampling Aggregates.
 - d. D698, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft³ (600 kN-m/m³)).
 - e. D1556, Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method.
 - f. D1557, Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft³ (2,700 kN-m/m³)).
 - g. D4253, Standard Test Methods for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table.
 - h. D4254, Standard Test Method for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density.
 - i. D6938, Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).

1.02 DEFINITIONS

A. Relative Compaction:

1. Ratio, in percent, of as-compacted field dry density to laboratory maximum dry density as determined in accordance with ASTM D1557.
2. Apply corrections for oversize material to either as-compacted field dry density or maximum dry density, as determined by Engineer.

B. Optimum Moisture Content:

1. Determined in accordance with ASTM Standard specified to determine maximum dry density for relative compaction.
2. Determine field moisture content on basis of fraction passing 3/4-inch sieve.

- C. Relative Density: Calculated in accordance with ASTM D4254 based on maximum index density determined in accordance with ASTM D4253 and minimum index density determined in accordance with ASTM D4254.
- D. Prepared Ground Surface: Ground surface after completion of required demolition, clearing and grubbing, scalping of sod, stripping of topsoil, excavation to grade, and subgrade preparation.
- E. Completed Course: A course or layer that is ready for next layer or next phase of Work.
- F. Lift: Loose (uncompacted) layer of material.
- G. Well-Graded:
 - 1. A mixture of particle sizes with no specific concentration or lack thereof of one or more sizes.
 - 2. Does not define numerical value that must be placed on coefficient of uniformity, coefficient of curvature, or other specific grain size distribution parameters.
 - 3. Used to define material type that, when compacted, produces a strong and relatively incompressible soil mass free from detrimental voids.
- H. Influence Area: Area within planes sloped downward and outward at 60-degree angle from horizontal measured from:
 - 1. 1 foot outside outermost edge at base of foundations or slabs.
 - 2. 1 foot outside outermost edge at surface of roadways or shoulder.
 - 3. 0.5 foot outside exterior at spring line of pipes or culverts.
- I. Borrow Material: Material from required excavations or from designated borrow areas on or near Site.
- J. Selected Backfill Material: Materials available onsite that Engineer determines to be suitable for specific use.
- K. Imported Material: Materials obtained from sources offsite, suitable for specified use.
- L. Structural Fill: Fill materials as required under structures, pavements, and other facilities.
- M. Embankment Material: Fill materials required to raise existing grade in areas other than under structures.

1.03 SUBMITTALS

A. Informational Submittals:

1. Manufacturer's data sheets for compaction equipment.
2. Certified test results from independent testing agency.

1.04 QUALITY ASSURANCE

A. Notify Engineer when:

1. Structure or tank is ready for backfilling, and whenever backfilling operations are resumed after a period of inactivity.
2. Soft or loose subgrade materials are encountered wherever embankment or site fill is to be placed.
3. Fill material appears to be deviating from Specifications.

1.05 SEQUENCING AND SCHEDULING

- A. Complete applicable Work specified in Section 02 41 00, Demolition; Section 31 23 16, Excavation; and Section 31 23 13, Subgrade Preparation, prior to placing fill or backfill.
- B. Backfill against concrete structures only after concrete has attained compressive strength, specified in Section 03 30 00, Cast-in-Place Concrete. Obtain Engineer's acceptance of concrete work and attained strength prior to placing backfill.
- C. Backfill around water-holding structures only after completion of satisfactory leakage tests as specified in Section 03 30 00, Cast-in-Place Concrete.
- D. Do not place granular base, subbase, or surfacing until after subgrade has been prepared as specified in Section 31 23 13, Subgrade Preparation.

PART 2 PRODUCTS

2.01 SOURCE QUALITY CONTROL

- A. Gradation Tests: As necessary to locate acceptable sources of imported material.

2.02 EARTHFILL

- A. Excavated material from required excavations free from rocks larger than 3 inches, from roots and other organic matter, ashes, cinders, trash, debris, and other deleterious materials.

- B. Material containing more than 10 percent gravel, stones, or shale particles is unacceptable.
- C. Provide imported material of equivalent quality, if required to accomplish Work.

2.03 GRANULAR FILL

- A. 1-inch minus crushed gravel or crushed rock.
- B. Free from dirt, clay balls, and organic material.
- C. Well-graded from coarse to fine and containing sufficient fines to bind material when compacted, but with maximum 8 percent by weight passing No. 200 sieve.

2.04 SAND

- A. Free from clay, organic matter, or other deleterious material.
- B. Gradation as determined in accordance with ASTM C117 and ASTM C136:

<u>Sieve Size</u>	<u>Percent Passing by Weight</u>
1/4-inch	100
No. 4	95 - 100
No. 200	0 - 8

PART 3 EXECUTION

3.01 GENERAL

- A. Keep placement surfaces free of water, debris, and foreign material during placement and compaction of fill and backfill materials.
- B. Place and spread fill and backfill materials in horizontal lifts of uniform thickness, in a manner that avoids segregation, and compact each lift to specified densities prior to placing succeeding lifts. Slope lifts only where necessary to conform to final grades or as necessary to keep placement surfaces drained of water.
- C. During filling and backfilling, keep level of fill and backfill around each structure and buried tank even.
- D. Do not place fill or backfill, if fill or backfill material is frozen, or if surface upon which fill or backfill is to be placed is frozen.

- E. If pipe, conduit, duct bank, or cable is to be laid within fill or backfill:
 - 1. Fill or backfill to an elevation 2 feet above top of item to be laid.
 - 2. Excavate trench for installation of item.
 - 3. Install bedding, if applicable, as specified in Section 31 23 23.15, Trench Backfill.
 - 4. Install item.
 - 5. Backfill envelope zone and remaining trench, as specified in Section 31 23 23.15, Trench Backfill, before resuming filling or backfilling specified in this section.
- F. Tolerances:
 - 1. Final Lines and Grades: Within a tolerance of 0.1 foot unless dimensions or grades are shown or specified otherwise.
 - 2. Grade to establish and maintain slopes and drainage as shown. Reverse slopes are not permitted.
- G. Settlement: Correct and repair any subsequent damage to structures, pavements, curbs, slabs, piping, and other facilities, caused by settlement of fill or backfill material.

3.02 BACKFILL UNDER AND AROUND STRUCTURES

- A. Under Facilities: Within influence area beneath structures, slabs, pavements, curbs, piping, conduits, duct banks, and other facilities, backfill with granular fill, unless otherwise shown. Place granular fill in lifts of 6-inch maximum thickness and compact each lift to minimum of 95 percent relative compaction as determined in accordance with ASTM D1557, Method 90 percent relative density.
- B. Other Areas: Backfill with earthfill to lines and grades shown, with proper allowance for topsoil thickness where shown. Place in lifts of 6-inch maximum thickness and compact each lift to minimum 100 percent relative compaction as determined in accordance with ASTM D1557, Method 90 relative density.

3.03 FILL

- A. Outside Influence Areas beneath Structures, Tanks, Pavements, Curbs, Slabs, Piping, and Other Facilities: Unless otherwise shown, place earthfill as follows:
 - 1. Allow for 6-inch thickness of topsoil where required.
 - 2. Maximum 8 inch thick lifts.
 - 3. Place and compact fill across full width of embankment.

4. Compact to minimum 90 percent relative compaction as determined in accordance with ASTM D1557. Dress completed embankment with allowance for topsoil, crest surfacing, and slope protection, where applicable.

3.04 SITE TESTING

- A. In-Place Density Tests: In accordance with ASTM D1556 or D6938. During placement of materials, test as follows:
 1. Fill and Backfill Material: One test for every 2 feet of lift interval per 2,000 square feet.
 2. Graded Aggregate Base Rock: As specified in 32 11 23, Aggregate Base Courses.

3.05 REPLACING OVEREXCAVATED MATERIAL

- A. Replace excavation carried below grade lines shown or established by Engineer as follows:
 1. Beneath Footings: Concrete fill, as specified in Section 03 30 00, Cast-in-Place Concrete.
 2. Beneath Fill or Backfill: Same material as specified for overlying fill or backfill.
 3. Beneath Slabs-On-Grade: Granular fill.
 4. Trenches:
 - a. Unauthorized Overexcavation: Either trench stabilization material or granular pipe base material, as specified in Section 31 23 23.15, Trench Backfill.
 - b. Authorized Overexcavation: Trench stabilization material, as specified in Section 31 23 23.15, Trench Backfill.

END OF SECTION

SECTION 31 23 23.15 TRENCH BACKFILL

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American Public Works Association (APWA): Uniform Color Code.
2. ASTM International (ASTM):
 - a. C33/C33M, Standard Specification for Concrete Aggregates.
 - b. C94/C94M, Standard Specification for Ready-Mixed Concrete.
 - c. C117, Standard Test Method for Materials Finer than 75 Micrometer (No. 200) Sieve in Mineral Aggregates by Washing.
 - d. C136, Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
 - e. C150/C150M, Standard Specification for Portland Cement.
 - f. C618, Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete.
 - g. C1012/C1012M, Standard Test Method for Length Change of Hydraulic-Cement Mortars Exposed to a Sulfate Solution.
 - h. D698, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft³ (600 kN-m/m³)).
 - i. D1140, Standard Test Methods for Amount of Material in Soils Finer than No. 200 (75 micrometer) Sieve.
 - j. D1557, Standard Test Methods for Laboratory Compaction Characteristics of Soil using Modified Effort (56,000 ft-lbf/ft³ (2,700 kN-m/m³)).
 - k. D2487, Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System).
 - l. D4253, Standard Test Methods for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table.
 - m. D4254, Standard Test Methods for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density.
 - n. D4318, Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.
 - o. D4832, Standard Test Method for Preparation and Testing of Controlled Low Strength Material (CLSM) Test Cylinders.
3. National Electrical Manufacturers Association (NEMA): Z535.1, Safety Colors.

1.02 DEFINITIONS

- A. Base Rock: Granular material upon which manhole bases and other structures are placed.
- B. Bedding Material: Granular material upon which pipes, conduits, cables, or duct banks are placed.
- C. Imported Material: Material obtained by Contractor from source(s) offsite.
- D. Lift: Loose (uncompacted) layer of material.
- E. Pipe Zone: Backfill zone that includes full trench width and extends from prepared trench bottom to an upper limit above top outside surface of pipe, conduit, cable or duct bank.
- F. Prepared Trench Bottom: Graded trench bottom after excavation and installation of stabilization material, if required, but before installation of bedding material.
- G. Relative Compaction: The ratio, in percent, of the as-compacted field dry density to the laboratory maximum dry density as determined by ASTM D1557. Corrections for oversize material may be applied to either as-compacted field dry density or maximum dry density, as determined by Engineer.
- H. Relative Density: As defined by ASTM D4253 and ASTM D4254.
- I. Selected Backfill Material: Material available onsite that Engineer determines to be suitable for a specific use.
- J. Well-Graded: A mixture of particle sizes that has no specific concentration or lack thereof of one or more sizes producing a material type that, when compacted, produces a strong and relatively incompressible soil mass free from detrimental voids. Satisfying both of the following requirements, as defined in ASTM D2487:
 - 1. Coefficient of Curvature: Greater than or equal to 1 and less than or equal to 3.
 - 2. Coefficient of Uniformity: Greater than or equal to 4 for materials classified as gravel, and greater than or equal to 6 for materials classified as sand.

1.03 SUBMITTALS

A. Action Submittals:

1. Shop Drawings: Manufacturer's descriptive literature for marking tapes.

B. Informational Submittals:

1. Catalog and manufacturer's data sheets for compaction equipment.
2. Certified Gradation Analysis: Submit not less than 30 days prior to delivery for imported materials or anticipated use for excavated materials, except for trench stabilization material that will be submitted prior to material delivery to Site.
3. Controlled Low Strength Material: Certified mix design and test results. Include material types and weight per cubic yard for each component of mix.

PART 2 PRODUCTS

2.01 MARKING TAPE

A. Nondetectable:

1. Inert polyethylene, impervious to known alkalis, acids, chemical reagents, and solvents likely to be encountered in soil.
2. Thickness: Minimum 5 mils.
3. Width: 3 inches.
4. Identifying Lettering: Minimum 1-inch high, permanent black lettering imprinted continuously over entire length.
5. Manufacturers and Products:
 - a. Reef Industries; Terra Tape.
 - b. Mutual Industries; Non-detectable Tape.
 - c. Presco; Non-detectable Tape.

B. Detectable:

1. Solid aluminum foil, visible on unprinted side, encased in protective high visibility, inert polyethylene plastic jacket.
2. Foil Thickness: Minimum 0.35 mils.
3. Laminate Thickness: Minimum 5 mils.
4. Width: 3 inches.
5. Identifying Lettering: Minimum 1-inch high, permanent black lettering imprinted continuously over entire length.
6. Joining Clips: Tin or nickel-coated furnished by tape manufacturer.

7. Manufacturers and Products:
 - a. Reef Industries; Terra Tape, Sentry Line Detectable.
 - b. Mutual Industries; Detectable Tape.
 - c. Presco; Detectable Tape.

C. Color: In accordance with APWA Uniform Color Code.

Color*	Facility
Red	Electric power lines, cables, conduit, and lightning cables
Orange	Communicating alarm or signal lines, cables, or conduit
Yellow	Gas, oil, steam, petroleum, or gaseous materials
Green	Sewers and drain lines
Blue	Potable water
Purple	Reclaimed water, irrigation, and slurry lines
*As specified in NEMA Z535.1, Safety Color Code.	

2.02 TRENCH STABILIZATION MATERIAL

- A. Granular Backfill: As specified in Section 31 23 23, Fill and Backfill.

2.03 BEDDING MATERIAL AND PIPE ZONE MATERIAL

- A. Unfrozen, friable, and no clay balls, roots, or other organic material.
- B. Clean or gravelly sand with less than 5 percent passing No. 200 sieve, as determined in accordance with ASTM D1140, or gravel or crushed rock within maximum particle size and other requirements as follows unless otherwise specified.
 1. Duct Banks: 3/4-inch maximum particle size.
 2. PVC Irrigation System Piping and Ductile Iron Pipe with Polyethylene Wrap: 3/8-inch maximum particle size.
 3. Pipe Under 18-Inch Diameter: 3/4-inch maximum particle size, except 1/4 inch for stainless steel pipe, copper pipe, tubing, and plastic pipe under 3-inch diameter.
 4. Pipe 18-Inch Diameter and Greater: 1-1/2-inch maximum particle size for ductile iron pipe, concrete pipe, welded steel pipe, and pretensioned or prestressed concrete cylinder pipe.
 5. Conduit and Direct-Buried Cable:
 - a. Sand, clean or clean to silty, less than 12 percent passing No. 200 sieve.
 - b. Individual Particles: Free of sharp edges.

- c. Maximum Size Particle: Pass a No. 4 sieve.
- d. If more than 5 percent passes No. 200 sieve, the fraction that passes No. 40 sieve shall be nonplastic as determined in accordance with ASTM D4318.

2.04 EARTH BACKFILL

- A. Soil, loam, or other excavated material suitable for use as backfill.
- B. Free from roots or organic matter, refuse, boulders and material larger than 1/2 cubic foot, or other deleterious materials.

2.05 CONCRETE BACKFILL

- A. Provide as specified in Section 03 30 00, Cast-in-Place Concrete.

2.06 GRAVEL SURFACING ROCK

- A. As specified in Section 32 11 23, Aggregate Base Courses.

2.07 TOPSOIL

- A. As specified in Section 32 91 13, Soil Preparation.

2.08 SOURCE QUALITY CONTROL

- A. Perform gradation analysis in accordance with ASTM C136 for:
 - 1. Earth backfill, including specified class.
 - 2. Trench stabilization material.
 - 3. Bedding and pipe zone material.
- B. Certify Laboratory Performance of Mix Designs: Concrete.

PART 3 EXECUTION

3.01 TRENCH PREPARATION

- A. Water Control:
 - 1. Promptly remove and dispose of water entering trench as necessary to grade trench bottom and to compact backfill and install manholes, pipe, conduit, direct-buried cable, or duct bank. Do not place concrete, lay pipe, conduit, direct-buried cable, or duct bank in water.
 - 2. Remove water in a manner that minimizes soil erosion from trench sides and bottom.
 - 3. Provide continuous water control until trench backfill is complete.

- B. Remove foreign material and backfill contaminated with foreign material that falls into trench.

3.02 TRENCH BOTTOM

- A. Firm Subgrade: Grade with hand tools, remove loose and disturbed material, and trim off high areas and ridges left by excavating bucket teeth. Allow space for bedding material if shown or specified.
- B. Soft Subgrade: If subgrade is encountered that may require removal to prevent pipe settlement, notify Engineer. Engineer will determine depth of overexcavation, if any required.

3.03 TRENCH STABILIZATION MATERIAL INSTALLATION

- A. Rebuild trench bottom with trench stabilization material.
- B. Place material over full width of trench in 6-inch lifts to required grade, providing allowance for bedding thickness.
- C. Compact each lift so as to provide a firm, unyielding support for the bedding material prior to placing succeeding lifts.

3.04 BEDDING

- A. Furnish imported bedding material where, in the opinion of Engineer, excavated material is unsuitable for bedding or insufficient in quantity.
- B. Place over full width of prepared trench bottom in two equal lifts when required depth exceeds 8 inches.
- C. Hand grade and compact each lift to provide a firm, unyielding surface.
- D. Minimum Thickness: As follows:
 - 1. Pipe 15 Inches and Smaller: 4 inches.
 - 2. Conduit: 3 inches.
 - 3. Direct-Buried Cable: 3 inches.
 - 4. Duct Banks: 3 inches.
- E. Check grade and correct irregularities in bedding material. Loosen top 1 inch to 2 inches of compacted bedding material with a rake or by other means to provide a cushion before laying each section of pipe, conduit, direct-buried cable, or duct bank.
- F. Install to form continuous and uniform support except at bell holes, if applicable, or minor disturbances resulting from removal of lifting tackle.

- G. Bell or Coupling Holes: Excavate in bedding at each joint to permit proper assembly and inspection of joint and to provide uniform bearing along barrel of pipe or conduit.

3.05 BACKFILL PIPE ZONE

- A. Upper limit of pipe zone shall not be less than following:
 - 1. Pipe: 12 inches, unless shown otherwise.
 - 2. Conduit: 3 inches, unless shown otherwise.
 - 3. Direct-Buried Cable: 3 inches, unless shown otherwise.
 - 4. Duct Bank: 3 inches, unless shown otherwise.
- B. Restrain pipe, conduit, cables, and duct banks as necessary to prevent their movement during backfill operations.
- C. Place material simultaneously in lifts on both sides of pipe and, if applicable, between pipes, conduit, cables, and duct banks installed in same trench.
 - 1. Pipe 10-Inch and Smaller Diameter: First lift less than or equal to 1/2 pipe diameter.
 - 2. Pipe Over 10-Inch Diameter: Maximum 6-inch lifts.
- D. Thoroughly tamp each lift, including area under haunches, with handheld tamping bars supplemented by “walking in” and slicing material under haunches with a shovel to ensure voids are completely filled before placing each succeeding lift.
- E. After full depth of pipe zone material has been placed as specified, compact material by a minimum of three passes with vibratory plate compactor only over area between sides of pipe and trench walls.

3.06 MARKING TAPE INSTALLATION

- A. Continuously install marking tape along centerline of buried piping, on top of last lift of pipe zone material. Coordinate with piping installation drawings.
 - 1. Detectable Marking Tape: Install with nonmetallic piping and waterlines.
 - 2. Nondetectable Marking Tape: Install with metallic piping.

3.07 BACKFILL ABOVE PIPE ZONE

- A. General:
 - 1. Process excavated material to meet specified gradation requirements.
 - 2. Adjust moisture content as necessary to obtain specified compaction.

3. Do not allow backfill to free fall into trench or allow heavy, sharp pieces of material to be placed as backfill until after at least 2 feet of backfill has been provided over top of pipe.
4. Do not use power driven impact type compactors for compaction until at least 4 feet of backfill is placed over top of pipe.
5. Backfill to grade with proper allowances for topsoil, crushed rock surfacing, and pavement thicknesses, wherever applicable.
6. Backfill around structures with same class backfill as specified for adjacent trench, unless otherwise shown or specified.

3.08 REPLACEMENT OF TOPSOIL

- A. Replace topsoil in top 4 inches of backfilled trench.
- B. Maintain finished grade of topsoil even with adjacent area and grade as necessary to restore drainage.

3.09 MAINTENANCE OF TRENCH BACKFILL

- A. After each section of trench is backfilled, maintain surface of backfilled trench even with adjacent ground surface until final surface restoration is completed.
- B. Gravel Surfacing Rock: Add gravel surfacing rock where applicable and as necessary to keep surface of backfilled trench even with adjacent ground surface, and grade and compact as necessary to keep surface of backfilled trenches smooth, free from ruts and potholes, and suitable for normal traffic flow.
- C. Topsoil: Add topsoil where applicable and as necessary to maintain surface of backfilled trench level with adjacent ground surface.
- D. Other Areas: Add excavated material where applicable and keep surface of backfilled trench level with adjacent ground surface.

3.10 SETTLEMENT OF BACKFILL

- A. Settlement of trench backfill, or of fill, or facilities constructed over trench backfill will be considered a result of defective compaction of trench backfill.

END OF SECTION

**SECTION 31 32 00
SOIL STABILIZATION**

PART 1 GENERAL

1.01 REFERENCES

- A. The following is a list of standards that may be referenced in this section:
 - 1. Official Seed Analysts of North America.

1.02 DEFINITIONS

- A. Maintenance Period: Begin maintenance immediately after each area is planted and continue for a period of 8 weeks after planting under this section is completed.
- B. Satisfactory Stand: Grass or section of grass of 10,000 square feet or larger that has:
 - 1. No bare spots larger than 3 square feet.
 - 2. Not more than 10 percent of total area with bare spots larger than 1 square foot.
 - 3. Not more than 15 percent of total area with bare spots larger than 6 square inches.

1.03 SUBMITTALS

- A. Action Submittals: Product data for commercial products; seed, fertilizer, and lime.
- B. Informational Submittals:
 - 1. Seed certifications.
 - 2. Copies of delivery invoices or other proof of quantities of mulch, lime, and fertilizer.
 - 3. Manufacturer's Installation Instructions: Commercial products.

1.04 DELIVERY, STORAGE, AND PROTECTION

- A. As specified in Section 32 92 00, Turf and Grasses.

1.05 SEQUENCING AND SCHEDULING

- A. As specified in Section 32 92 00, Turf and Grasses.
- B. Prepare topsoil as specified in Section 32 91 13, Soil Preparation, before starting Work of this section.

- C. Complete soil preparation, seeding, liming, fertilizing, and mulching within 10 days after final grades have been reached.
- D. Notify Engineer at least 3 days in advance of:
 - 1. Materials delivery.
 - 2. Start of planting/seeding activity.
- E. Seeding: Perform under favorable weather conditions during seasons that are normal for such Work as determined by accepted local practice.

1.06 MAINTENANCE

- A. Operations:
 - 1. As specified in Section 32 92 00, Turf and Grasses.
 - a. Watering: Keep seeded surface moist.
 - b. Washouts: Repair by filling with topsoil, fertilizing, seeding, and mulching.
 - c. Mulch: Replace wherever and whenever washed or blown away.
 - d. Reseed unsatisfactory areas or portions thereof immediately at end of maintenance period if a satisfactory stand has not been produced.
 - e. Reseed during next planting season if scheduled end of maintenance period falls after September 15.
 - f. Reseed entire area if satisfactory stand does not develop by July 1 of the following year of the following year.

PART 2 PRODUCTS

2.01 FERTILIZER

- A. Commercial, uniform in composition, free-flowing, suitable for application with equipment designed for that purpose.
- B. Fertilizer shall have the following minimum percentage of plant food by weight:
 - 1. Summer Mix:
 - a. Nitrogen: 20 percent.
 - b. Phosphoric Acid: 10 percent.
 - c. Potash: 10 percent.
 - 2. Winter Mix:
 - a. Nitrogen: 16 percent.
 - b. Phosphoric Acid: 8 percent.
 - c. Potash: 0 percent.

2.02 SEED

- A. As specified in Section 32 92 00, Turf and Grasses.

2.03 MULCH

- A. Wood Cellulose Fiber Mulch:

1. Specially processed wood fiber containing no growth or germination inhibiting factors.
2. Dyed suitable color to facilitate inspection of material placement.
3. Manufactured such that after addition and agitation in slurry tanks with water, material fibers become uniformly suspended to form homogenous slurry.
4. When hydraulically sprayed on ground, material will allow absorption and percolation of moisture.

- B. Straw:

1. As specified in Section 32 92 00, Turf and Grasses. Suitable for spreading with mulch blower equipment.
2. Average Stalk Length: 6 inches.
3. Seasoned before baling or loading.

PART 3 EXECUTION

3.01 SOIL PREPARATION

- A. As specified in Section 32 91 13, Soil Preparation.

3.02 SEEDING

- A. As specified in Section 32 92 00, Turf and Grasses.

3.03 MULCHING

- A. Apply uniformly on seeded areas.
- B. Application: Sufficiently loose to permit penetration of sunlight and air circulation, and sufficiently dense to shade ground, reduce evaporation rate, and prevent or materially reduce erosion of underlying soil.
 1. Straw: Apply by hand or mechanical means to minimum depth of 2 inches.
 2. Wood Cellulose Fiber: 1,000 to 1,500 pounds per acre.

3.04 FIELD QUALITY CONTROL

- A. Upon completion of maintenance period and on written notice from Contractor, Engineer will within 15 days of receipt, determine if a satisfactory stand has been established.
- B. If a satisfactory stand has not been established, Engineer will make another determination upon written notice from Contractor following the next growing season.

END OF SECTION

**SECTION 31 41 00
SHORING**

PART 1 GENERAL

1.01 SUBMITTALS

A. Informational Submittals:

1. Excavation support plan.
2. Movement monitoring plan.
3. Trench excavation plan.
4. Movement measurement and data and reduced results indicating movement trends.

1.02 QUALITY ASSURANCE

- A.** Provide surveys to monitor movements of critical facilities.
- B.** Conform to the requirements of the OSHA Standards and Interpretations; “29 CFR Part I 1926.650 Subpart P – Excavation, Trenching, and Shoring,” and all other applicable laws, regulations, rules, and codes

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 GENERAL

- A.** Design, provide, and maintain shoring, sheeting, and bracing as necessary to support the sides of excavations and to prevent detrimental settlement and lateral movement of existing facilities, adjacent property, and completed the Work.
- B.** If the Engineer is of the opinion that at any point sufficient or proper supports have not been provided, he/she may order additional supports placed at the expense of the Contractor. Compliance with such order shall not relieve the Contractor from his/her responsibility for the sufficiency of such supports. Care shall be taken to prevent voids outside of the sheeting, but if voids are formed, they shall be immediately filled and rammed.
- C.** Shoring system shall provide suitable room for installing pipe, structures and appurtenances.
- D.** When movable trench bracing such as trench boxes, movable sheeting, shoring or plates are used to support the sides of the trench, care shall be taken in placing and moving the boxes or supporting bracing to prevent movement of the pipe, or disturbances of the pipe bedding and the screened gravel backfill.

3.02 EXCAVATION SUPPORT PLAN

- A. Prepare excavation support plan addressing following topics:
 - 1. Details of shoring, bracing, sloping, or other provisions for worker protection from hazards of caving ground.
 - 2. Design assumptions and calculations.
 - 3. Methods and sequencing of installing excavation support.
 - 4. Proposed locations of stockpiled excavated material.
 - 5. Minimum lateral distance from the crest of slopes for vehicles and stockpiled excavated materials.
 - 6. Anticipated difficulties and proposed resolutions.

3.03 MOVEMENT MONITORING PLAN

- A. Prepare movement monitoring plan addressing following topics:
 - 1. Survey control.
 - 2. Location of monitoring points.
 - 3. Plots of data trends.
 - 4. Interval between surveys.

3.04 REMOVAL OF EXCAVATION SUPPORT

- A. Remove excavation support in a manner that will maintain support as excavation is backfilled.
- B. Do not begin to remove excavation support until support can be removed without damage to existing facilities, completed Work, or adjacent property.
- C. Remove excavation support in a manner that does not leave voids in the backfill.

3.05 TRENCHES

- A. For trench excavation exceeding 5 feet in depth, provide adequate safety system meeting requirements of applicable state and local construction safety orders, and federal requirements.
- B. All excavation, trenching, and related sheeting, bracing, etc. shall comply with the requirements of OSHA excavation safety standards (29 CFR Part 1926.650 Subpart P) and State requirements. Where conflict between OSHA and State regulations exists, the more stringent requirements shall apply.

END OF SECTION

SECTION 32 11 23
AGGREGATE BASE COURSE(S)

PART 1 GENERAL

1.01 DEFINITIONS

- A. Completed Course: Compacted, unyielding, free from irregularities, with smooth, tight, even surface, true to grade, line, and cross-section.
- B. Completed Lift: Compacted with uniform cross-section thickness.

1.02 SUBMITTALS

- A. Informational Submittals: Certified Test Results on Source Materials: Submit copies from commercial testing laboratory 30 days prior to delivery of materials to Project showing materials meeting the physical qualities specified.

PART 2 PRODUCTS

2.01 GRADED AGGREGATE BASE

- A. As specified for Group I Aggregates in Section 815 of the Standard Specifications.

2.02 GRAVEL SURFACING

- A. Size No. 57 coarse aggregates as specified in Section 800 of the Standard Specifications.
- B. Clean, tough, uniform quality, durable fragments of crushed rock, free from flat, elongated, soft or disintegrated pieces, or other objectionable matter occurring either free or as coating on stone.
- C. Physical Qualities: Same as for base course.

2.03 SOURCE QUALITY CONTROL

- A. Perform tests necessary to locate acceptable source of materials meeting specified requirements.
- B. Final approval of aggregate material will be based on test results of installed materials.
- C. Should separation of coarse from fine materials occur during processing or stockpiling, immediately change methods of handling materials to correct uniformity in grading.

PART 3 EXECUTION

3.01 SUBGRADE PREPARATION

- A. As specified in Section 31 23 13, Subgrade Preparation.
- B. Obtain Engineer's acceptance of subgrade before placing base course or surfacing material.
- C. Do not place base course or surfacing materials in snow or on soft, muddy, or frozen subgrade.

3.02 EQUIPMENT

- A. Compaction Equipment: Adequate in design and number to provide compaction and to obtain specified density for each layer.

3.03 HAULING AND SPREADING

- A. Hauling Materials:
 - 1. Do not haul over surfacing in process of construction.
 - 2. Loads: Of uniform capacity.
 - 3. Maintain consistent gradation of material delivered; loads of widely varying gradations will be cause for rejection.
- B. Spreading Materials:
 - 1. Distribute material to provide required density, depth, grade, and dimensions with allowance for subsequent lifts.
 - 2. Produce even distribution of material upon roadway or prepared surface without segregation.
 - 3. Should segregation of coarse from fine materials occur during placing, immediately change methods of handling materials to correct uniformity in grading.

3.04 CONSTRUCTION OF COURSES

- A. General: Complete each lift in advance of laying succeeding lift to provide required results and adequate inspection.
- B. Graded Aggregate Base:
 - 1. Maximum Completed Lift Thickness: 6 inches.
 - 2. Completed Course Total Thickness: As shown.
 - 3. Spread lift on preceding course to required cross-section.
 - 4. Lightly blade and roll surface until thoroughly compacted.

5. Add keystone to achieve compaction and as required when aggregate does not compact readily because of lack of fines or natural cementing properties, as follows:
 - a. Use leveling course or surfacing material as keystone.
 - b. Spread evenly on top of base course, using spreader boxes or chip spreaders.
 - c. Roll surface until keystone is worked into interstices of base course without excessive displacement.
 - d. Continue operation until course has become thoroughly keyed, compacted, and will not creep or move under roller.
 6. Blade or broom surface to maintain true line, grade, and cross-section.
- C. Gravel Surfacing:
1. Maximum Completed Lift Thickness: 4 inches.
 2. Completed Course Total Thickness: As shown.
 3. Spread on preceding course in accordance with cross-section shown.
 4. Blade lightly and roll surface until material is thoroughly compacted.

3.05 ROLLING AND COMPACTION

- A. Commence compaction of each layer of base after spreading operations and continue until density of 98 percent of maximum density has been achieved as determined by ASTM D698.
- B. Roll each layer of material until material does not creep under roller before succeeding layer is applied.
- C. Commence rolling at outer edges and continue toward center; do not roll center of road first.
- D. Apply water as needed to obtain specified densities.
- E. Place and compact each lift to the required density before succeeding lift is placed.
- F. Remove floating or loose stone from surface of preceding course before placing leveling course.
- G. Surface Defects: Remedy by loosening and rerolling. Reroll entire area, including surrounding surface, until thoroughly compacted.
- H. Finished surface shall be true to grade and crown before proceeding with surfacing.

3.06 SURFACE TOLERANCES

- A. Blade or otherwise work surfacing as necessary to maintain grade and cross-section at all times, and to keep surface smooth and thoroughly compacted.
- B. Finished Surface of Untreated Aggregate Base Course: Within plus or minus 0.04 foot of grade shown at any individual point.
- C. Gravel Surfacing: Within 0.04 foot from lower edge of 10-foot straightedge placed on finished surface, parallel to centerline.

3.07 FIELD QUALITY CONTROL

- A. In-Place Density Tests: In accordance with ASTM D698. Construct base course so areas shall be ready for testing.
- B. Frequency: Perform a minimum of one test on completed course per 2,000 square feet.

3.08 CLEANING

- A. Remove excess material from the Work area. Clean stockpile and staging areas of all excess aggregate.

END OF SECTION

**SECTION 32 16 00
CURBS AND GUTTERS**

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American Association of State Highway and Transportation Officials (AASHTO): T 99, Standard Specification for the Moisture-Density Relations of Soils Using a 2.5 kg (5.5 pound) Rammer and a 305 mm (12 inch) Drop.
2. American Concrete Institute (ACI): 304R, Guide for Measuring, Mixing, Transporting, and Placing Concrete.
3. ASTM International (ASTM):
 - a. C94, Standard Specification for Ready-Mixed Concrete.
 - b. C309, Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete.
 - c. D994, Standard Specification for Preformed Expansion Joint Filler for Concrete (Bituminous Type).
4. Standard Specification: State of Georgia.

1.02 SUBMITTALS

A. Action Submittals:

1. Form Material: Information on metal forms, if used, including type, condition, surface finish, and intended function.
2. Complete data on concrete mix, including aggregate gradations and admixtures in accordance with requirements of ASTM C94.

B. Informational Submittals:

1. Curing Compound: Manufacturer's Certificate of Compliance, in accordance with Section 01 61 00, Common Product Requirements, and application instructions.
2. Ready-mix delivery ticket for each truck in accordance with ASTM C94.

1.03 QUALITY ASSURANCE

A. Regulatory Requirements: Conform to the State of Georgia Standard Specifications for Highway Construction.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Conform to the requirements of the referenced Standard Specification.

2.02 EXPANSION JOINT FILLER

- A. Preformed asphalt-impregnated, expansion joint material meeting ASTM D994, 1/2-inch thick.

2.03 CONCRETE

- A. Reference concrete mix design for concrete curbs and sidewalks in Section 03 30 00, Curing Compound.
- B. Liquid membrane forming, clear or translucent, suitable for spray application and meeting ASTM C309, Type 1.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Perform Work in accordance with the referenced Standard Specification.

3.02 FORMWORK

- A. Lumber Materials:
 - 1. 2-inch dressed dimension lumber, or metal of equal strength, straight, free from defects that would impair appearance or structural quality of completed curb and sidewalk.
 - 2. 1-inch dressed lumber or plywood may be used where short-radius forms are required.
- B. Metals: Steel in new undamaged condition.
- C. Setting Forms:
 - 1. Construct forms to shape, lines, grades, and dimensions.
 - 2. Stake securely in place.
- D. Bracing:
 - 1. Brace forms to prevent change of shape or movement resulting from placement.
 - 2. Construct short-radius curved forms to exact radius.

E. Tolerances:

1. Do not vary tops of forms from gradeline more than 1/8 inch when checked with 10-foot straightedge.
2. Do not vary alignment of straight sections more than 1/8 inch in 10 feet.

3.03 PLACING CONCRETE

- A. Prior to placing concrete, remove water from excavation and debris and foreign material from forms.
- B. Place concrete as soon as possible, and within 1-1/2 hours after adding cement to mix without segregation or loss of ingredients, and without splashing.
- C. Place, process, finish, and cure concrete in accordance with applicable requirements of ACI 304, and this section. Wherever requirements differ, the more stringent shall govern.
- D. To compact, vibrate until concrete becomes uniformly plastic.

3.04 CURB CONSTRUCTION

- A. Expansion Joints: Place at maximum 45-foot intervals, and at connections to existing curbs. Install expansion joint filler at each joint.
- B. Curb Facing: Do not allow horizontal joints within 7 inches from top of curb.
- C. Contraction Joints:
 1. Maximum 15-foot intervals in curb.
 2. Provide open joint type by inserting thin, oiled steel sheet vertically in fresh concrete to force coarse aggregate away from joint.
 3. Insert steel sheet to full depth of curb.
 4. Remove steel sheet with sawing motion after initial set has occurred in concrete and prior to removing front curb form.
 5. Finish top of curb with steel trowel and finish edges with steel edging tool.
- D. Front Face:
 1. Remove front form and finish exposed surfaces when concrete has set sufficiently to support its own weight.
 2. Finish formed face by rubbing with burlap sack or similar device to produce uniformly textured surface, free of form marks, honeycomb, and other defects.
 3. Remove and replace defective concrete.

4. Apply curing compound to exposed surfaces of curb upon completion of finishing.
 5. Continue curing for minimum of 5 days.
- E. Backfill curb with earth upon completion of curing period, but not before 7 days has elapsed since placing concrete.
1. Backfill shall be free from rocks 2 inches and larger and other foreign material.
 2. Compact backfill firmly.

3.05 SIDEWALK CONSTRUCTION

- A. Thickness: 4 inches in walk areas.
- B. Connection to Existing Sidewalk:
1. Remove old concrete back to an existing contraction joint.
 2. Clean the surface.
 3. Apply a neat cement paste immediately prior to placing new sidewalk.
- C. Expansion Joints: Place in adjacent curb, where sidewalk ends at curb, and around posts, poles, or other objects penetrating sidewalk. Install expansion joint filler at each joint.
- D. Contraction Joints:
1. Provide transversely to walks at locations opposite contraction joints in curb.
 2. Dimensions: 3/16-inch by 1-inch weakened plane joints.
 3. Construct straight and at right angles to surface of walk.
- E. Finish:
1. Broom surface with fine-hair broom at right angles to length of walk and tool at edges, joints, and markings.
 2. Mark walks transversely at 5-foot intervals with jointing tool; finish edges with rounded steel edging tool.
 3. Apply curing compound to exposed surfaces upon completion of finishing.
 4. Protect sidewalk from damage and allow to cure for at least 7 days.

END OF SECTION

SECTION 32 91 13 SOIL PREPARATION

PART 1 GENERAL

1.01 REFERENCES

- A. The following is a list of standards which may be referenced in this section:
 - 1. ASTM International (ASTM):
 - a. C33/C33M, Standard Specification for Concrete Aggregates.
 - b. C602, Standard Specification for Agricultural Liming Materials.
 - c. D2974, Standard Test Methods for Moisture, Ash, and Organic Matter of Peat and Other Organic Soils.
 - d. D5268, Standard Specification for Topsoil Used for Landscaping Purposes.

1.02 SUBMITTALS

- A. Action Submittals:
 - 1. Samples: Representative of stockpiled or imported topsoil.
- B. Informational Submittals:
 - 1. Certified Topsoil Analysis Reports:
 - a. Indicate quantities of materials necessary to bring onsite topsoil into compliance with textural/gradation requirements.
 - b. Indicate quantity of lime, quantity and analysis of fertilizer, and quantity and type of soil additive.

1.03 SEQUENCING AND SCHEDULING

- A. Rough grade areas to be planted or seeded prior to performing Work specified under this section.

PART 2 PRODUCTS

2.01 TOPSOIL

- A. General: Natural, friable, sandy loam, obtained from well-drained areas, free from objects larger than 1-1/2 inches maximum dimension, and free of subsoil, roots, grass, other foreign matter, hazardous or toxic substances, and deleterious material that may be harmful to plant growth or may hinder grading, planting, or maintenance.

- B. Composition: In general accordance with ASTM D5268:
 - 1. Gravel-Sized Fraction: Maximum 5 percent by weight retained on a No. 10 sieve.
 - 2. Sand-Sized Fraction: Minimum 20 to 60 percent passing No. 10 sieve.
 - 3. Silt and Clay-Sized Fraction: Minimum 35 to 70 percent.
- C. Organic Matter: Minimum 1.5 percent by dry weight as determined in accordance with ASTM D2974.
- D. pH: Range 5.0 to 7.0.
- E. Textural Amendments: Amend as necessary to conform to required composition by incorporating sand, peat, manure, or sawdust.
- F. Source: Import topsoil if onsite material is insufficient in quantity.

2.02 LIME

- A. Composition: Ground limestone with not less than 85 percent total carbonates, ASTM C602.
- B. Gradation:
 - 1. Minimum 50 percent passing No. 100 sieve.
 - 2. Minimum 90 percent passing No. 20 sieve.
 - 3. Coarser material acceptable provided rates of application are increased proportionately on basis of quantities passing No. 100 sieve.

2.03 SOIL ADDITIVES

- A. Sawdust or Ground Bark:
 - 1. Nontoxic, of uniform texture, and subject to slow decomposition when mixed with soil.
 - 2. Nitrogen-treated, or if untreated mix with minimum 0.15 pound of ammonium nitrate or 0.25 pound of ammonium sulfate per cubic foot of loose material.
- B. Peat:
 - 1. Composition: Natural residue formed by decomposition of reeds, sedges, or mosses in a freshwater environment, free from lumps, roots, and stones.
 - a. Organic Matter: Not less than 90 percent on a dry weight basis as determined by ASTM D2974.
 - b. Moisture Content: Maximum 65 percent by weight at time of delivery.

C. Fertilizer:

1. Natural:
 - a. Manure:
 - 1) Well-rotted, stable or cattle manure, free from weed seed and refuse.
 - 2) Maximum 50 percent sawdust or shavings by volume.
 - 3) Age: Minimum 4 months; maximum 2 years.
2. Commercial:
 - a. Commercial, uniform in composition, free-flowing, suitable for application with equipment designed for that purpose.
 - b. Contain the following minimum percentage of plant food by weight:
 - 1) Summer Mix:
 - a) Nitrogen: 20 percent.
 - b) Phosphoric Acid: 10 percent.
 - c) Potash: 10 percent.
 - 2) Winter Mix:
 - a) Nitrogen: 16 percent.
 - b) Phosphoric Acid: 8 percent.
 - c) Potash: 0 percent.

D. Sand: Fine Aggregate: Clean, coarse, well-graded, ASTM C33/C33M.

2.04 SOIL STERILANT

- A. Granular Calcium Cyanamide: Herbicide, manufactured by American Cyanamide Co.

2.05 SOURCE QUALITY CONTROL

- A. Topsoil Analysis/Testing: Performed by county or state soil testing service or approved certified independent testing laboratory.

PART 3 EXECUTION

3.01 SUBGRADE PREPARATION

- A. Apply lime at the rate of 50 pounds per 1,000 square feet to subgrade before tilling.
- B. Scarify subgrade to minimum depth of 6 inches where topsoil is to be placed.
- C. Remove stones over 2-1/2 inches in any dimension, sticks, roots, rubbish, and other extraneous material.
- D. Limit preparation to areas which will receive topsoil within 2 days after preparation.

3.02 TOPSOIL PLACEMENT

- A. Do not place topsoil when subsoil or topsoil is frozen, excessively wet, or otherwise detrimental to the Work.
- B. Mix soil amendments, lime, and other soil additives, identified in analysis reports with topsoil before placement or spread on topsoil surface and mix thoroughly into entire depth of topsoil before planting or seeding. Delay mixing of fertilizer if planting or seeding will not occur within 3 days.
- C. Place one-half of the total depth of topsoil and work into top 4 inches of subgrade soil to create a transition layer. Place remainder of topsoil to depth of 6 inches where seeding is are scheduled.
- D. Uniformly distribute to within 1/2 inch of final grades. Fine grade topsoil eliminating rough or low areas and maintaining levels, profiles, and contours of subgrade.
- E. Remove stones exceeding 1-1/2-inch diameter, roots, sticks, debris, and foreign matter during and after topsoil placement.
- F. Remove surplus subsoil and topsoil from Site. Grade stockpile area as necessary and place in condition acceptable for planting or seeding.

END OF SECTION

SECTION 32 92 00 TURF AND GRASSES

PART 1 GENERAL

1.01 DEFINITIONS

- A. Maintenance Period: Begin maintenance immediately after each area is planted (seed, sod, or sprig) and continue for a period of 8 weeks after all planting under this section is completed.
- B. Satisfactory Stand: Grass or section of grass that has:
 - 1. No bare spots larger than 3 square feet.
 - 2. Not more than 10 percent of total area with bare spots larger than 1 square foot.
 - 3. Not more than 15 percent of total area with bare spots larger than 6 square inches.

1.02 SUBMITTALS

- A. Action Submittals: Product labels/data sheets.
- B. Informational Submittals:
 - 1. Seed: Certification of seed analysis, germination rate, and inoculation:
 - a. Certify that each lot of seed has been tested by a testing laboratory certified in seed testing, within 6 months of date of delivery. Include with certification:
 - 1) Name and address of laboratory.
 - 2) Date of test.
 - 3) Lot number for each seed specified.
 - 4) Test Results: (i) name, (ii) percentages of purity and of germination, and (iii) weed content for each kind of seed furnished.
 - b. Mixtures: Proportions of each kind of seed.
 - 2. Seed Inoculant Certification: Bacteria prepared specifically for legume species to be inoculated.
 - 3. Certification of sod; include source and harvest date of sod, and sod seed mix.
 - 4. Certification of sprig type and name.
 - 5. Description of required maintenance activities and activity frequency.

1.03 DELIVERY, STORAGE, AND PROTECTION

A. Seed:

1. Furnish in standard containers with seed name, lot number, net weight, percentages of purity, germination, and hard seed and maximum weed seed content, clearly marked for each container of seed.
2. Keep dry during storage.

1.04 WEATHER RESTRICTIONS

- A. Perform Work under favorable weather and soil moisture conditions as determined by accepted local practice.

1.05 SEQUENCING AND SCHEDULING

- A. Prepare topsoil as specified in Section 32 91 13, Soil Preparation, before starting Work of this section.
- B. Complete Work under this section within 3 days following completion of soil preparation.
- C. Notify Engineer at least 3 days in advance of:
1. Each material delivery.
 2. Start of planting activity.
- D. Planting Season: Those times of year that are normal for such Work as determined by accepted local practice.

1.06 MAINTENANCE SERVICE

- A. Contractor: Perform maintenance operations during maintenance period to include:
1. Watering: Keep surface moist.
 2. Washouts: Repair by filling with topsoil, liming, fertilizing, seeding, and mulching.
 3. Mulch: Replace wherever and whenever washed or blown away.
 4. Mowing: Mow to 2 inches after grass height reaches 3 inches, and mow to maintain grass height from exceeding 3-1/2 inches.
 5. Reseed unsatisfactory areas or portions thereof immediately at the end of the maintenance period if a satisfactory stand has not been produced.
 6. Reseed/replant during next planting season if scheduled end of maintenance period falls after September 15.
 7. Reseed/replant entire area if satisfactory stand does not develop by July 1 of the following year.

PART 2 PRODUCTS

2.01 FERTILIZER

- A. Commercial, uniform in composition, free-flowing, suitable for application with equipment designed for that purpose. Minimum percentage of plant food by weight.
- B. Application Rates: Determined by soil analysis results.
- C. Mix:
 - 1. Nitrogen: 10.
 - 2. Phosphoric Acid: 10.
 - 3. Potash: 10.
 - 4. Bonemeal: Commercial, raw, finely ground, with minimum analysis of 4 percent nitrogen and 20 percent phosphoric acid.
 - 5. Superphosphate: Soluble mixture of phosphate obtained from treated mineral phosphates with minimum analysis of 20 percent available phosphoric acid.
- D. Top Dress Type: As recommended by local authority.

2.02 SEED

- A. Grass Type: Common Bermuda.
- B. Fresh, clean new-crop seed that complies with the tolerance for purity and germination established by Official Seed Analysts of North America.
- C. Seeds of Legumes: Inoculated with pure culture of nitrogen-fixing bacteria prepared specifically for legume species in accordance with inoculant manufacturer's instructions.

2.03 STRAW MULCH

- A. Threshed straw of oats, wheat, barley, or rye, free from (i) seed of noxious weeds or (ii) clean salt hay.

PART 3 EXECUTION

3.01 PREPARATION

- A. Grade areas to smooth, even surface with loose, uniformly fine texture.
 - 1. Roll and rake, remove ridges, fill depressions to meet finish grades.
 - 2. Limit such Work to areas to be planted within immediate future.

3. Remove debris, and stones larger than 1-1/2-inch diameter, and other objects that may interfere with planting and maintenance operations.
- B. Moisten prepared areas before planting if soil is dry. Water thoroughly and allow surface to dry off before seeding. Do not create muddy soil.
- C. Restore prepared areas to specified condition if eroded or otherwise disturbed after preparation and before planting.

3.02 FERTILIZER

- A. Apply evenly over area in accordance with manufacturer's instructions. Mix into top 2 inches of topsoil, when applied by broad cast method.
- B. Application Rate: 23 pounds per 1,000 square feet (1,000 pounds per acre).

3.03 SEEDING

- A. Start within 2 days of preparation completion.
- B. Flatter slopes may be mechanically seeded.
- C. Mechanical: Broadcast seed in two different directions, compact seeded area with cultipactor or roller.
 1. Sow seed at uniform rate of 23 pounds per 1,000 square feet.
 2. Use Brillion type seeder.
 3. Broadcasting will be allowed only in areas too small to use Brillion type seeder. Where seed is broadcast, increase seeding rate 20 percent.
 4. Roll with ring roller to cover seed, and water with fine spray.
- D. Cover Crop Seeding: Apply seed at rate of 120 pounds per acre to areas that are bare or incomplete after September 15.
- E. Mulching: Apply uniform cover of straw mulch at a rate of 2 tons per acre.
- F. Water: Apply with fine spray after mulching to saturate top 4 inches of soil.

3.04 FIELD QUALITY CONTROL

- A. Eight weeks after seeding is complete and on written notice from Contractor, Engineer will, within 15 days of receipt, determine if a satisfactory stand has been established.
- B. If a satisfactory stand has not been established, Engineer will make another determination after written notice from Contractor following the next growing season.

END OF SECTION

SECTION 33 13 00
DISINFECTION OF WATER UTILITY DISTRIBUTION FACILITIES

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American Water Works Association (AWWA):
 - a. B300, Hypochlorites.
 - b. B301, Liquid Chlorine.
 - c. B302, Ammonium Sulfate.
 - d. B303, Sodium Chlorite.
 - e. C651, Disinfecting Water Mains.
 - f. C652, Disinfection of Water Storage Facilities.
 - g. C653, Disinfection of Water Treatment Plants.
2. NSF International (NSF):
 - a. NSF/ANSI 61, Drinking Water System Components - Health Effects.
 - b. NSF/ANSI 372, Drinking Water System Components - Lead Content.
3. Standard Methods for the Examination of Water and Wastewater, as published by American Public Health Association, American Water Works Association, and the Water Environment Federation.

1.02 SUBMITTALS

A. Informational Submittals:

1. Plan describing and illustrating conformance to appropriate AWWA standards and this Specification.
2. Procedure and plan for cleaning system.
3. Procedures and plans for disinfection and testing.
4. Proposed locations within system where Samples will be taken.
5. Type of disinfecting solution and method of preparation.
6. Certification that employees working with concentrated chlorine solutions or gas have received appropriate safety training.
7. Method of disposal for highly chlorinated disinfecting water.
8. Independent Testing Agency: Certification that testing agency is qualified to perform bacteriological testing in accordance with AWWA standards, agency requirements, and this Specification.
9. Certified Bacteriological Test Results:
 - a. Facility tested is free from coliform bacteria contamination.
 - b. Forward results directly to Engineer.

1.03 QUALITY ASSURANCE

- A. Independent Testing Agency: Certified in the State of Georgia, with 10 years' experience in field of water sampling and testing. Agency shall use calibrated testing instruments and equipment, and documented standard procedures for performing specified testing.

1.04 SEQUENCING

- A. Commence disinfection after completion of following:
 - 1. Completion and acceptance of internal painting of system(s).
 - 2. Hydrostatic and pneumatic testing, pressure testing, functional and performance testing and acceptance of pipelines, pumping systems, structures, and equipment.
 - 3. Disinfection of: Pumps and associated system piping.

PART 2 PRODUCTS

2.01 GENERAL

- A. Components and Materials in Contact with Water for Human Consumption: Comply with the requirements of the Safe Drinking Water Act and other applicable federal, state, and local requirements. Provide certification by manufacturer or an accredited certification organization recognized by the Authority Having Jurisdiction that components and materials comply with the maximum lead content standard in accordance with NSF/ANSI 61 and NSF/ANSI 372.
 - 1. Use or reuse of components and materials without a traceable certification is prohibited.

2.02 WATER FOR DISINFECTION AND TESTING

- A. Clean, uncontaminated, and potable.
- B. Owner will supply potable quality water. Contractor shall convey in disinfected pipelines or containers.

2.03 DISINFECTANT

- A. Prepare "stock" solution by mixing any of the following as described below. The purpose of the stock solution is to facilitate mixing and dilution to ensure a uniform disinfecting solution. The Contractor will not be required to mix a stock solution if a liquid chlorine gas feed system can accurately feed a desired amount of chlorine to mix a final (dilute) disinfecting solution used.
 - 1. Calcium hypochlorite conforming to AWWA B300 or sodium hypochlorite conforming to AWWA B303 powder or liquid and water mixture.

- B. Use the following proportions of hypochlorite or chlorine to water:
1. Calcium Hypochlorite (65 to 70 percent Cl): 1 pound per 7.5 gallons water. If calcium hypochlorite is used, first mix dry powder with water to make a thick paste, then thin to a 1 percent solution (10,000 ppm chlorine).
 2. Sodium Hypochlorite (5.25 percent Cl): 1 gallon per 4.25 gallons water. If sodium hypochlorite procedure is used, dilute the liquid with water to obtain a 1 percent solution.

PART 3 EXECUTION

3.01 GENERAL

- A. Conform to AWWA C651 for pipes and pipelines and C653 for other components of the water treatment system, except as modified in these Specifications.
- B. Contractor's Equipment: Furnish chemicals and equipment, such as pumps and hoses, to accomplish disinfection.
- C. Disinfect the following items installed or modified under this Project, intended to hold, transport, or otherwise contact potable water:
1. Chlorine Dioxide Booster Pump.
 2. New ClO₂ pipeline that connect to existing pipelines up to point of connection.
 3. New plant service water pipes (W1 and W2).
 4. Disinfect surfaces of materials that will contact finished water, both during and following construction, using one of the methods described in AWWA C652 and AWWA C653. Disinfect prior to contact with finished water. Take care to avoid recontamination following disinfection.
- D. Prior to application of disinfectants, clean pump and pipelines of loose and suspended material.
- E. Allow freshwater and disinfectant solution to flow into pipe or vessel at a measured rate so chlorine-water solution is at specified strength. Do not place concentrated liquid commercial disinfectant in pipeline or other facilities to be disinfected before it is filled with water.

3.02 TURBIDITY

- A. Cleaning of equipment and facilities shall include removal of materials that result in a turbidity exceeding limits stated in Article Testing.

3.03 PIPING

A. Cleaning:

1. Before disinfecting, clean foreign matter from pipe in accordance with AWWA C651.
2. Flush pipe through flushing branches and remove branches after flushing is completed.

B. Disinfecting Procedure: In accordance with AWWA C651, unless herein modified.

3.04 PUMPS

A. Verify with equipment supplier that the materials of construction of the booster pump will not be impacted by the specified disinfection procedure. If impact to the materials is of concern, coordinate with the Engineer and equipment supplier for an alternative disinfection procedure.

B. Disinfecting Solutions: Minimum free chlorine concentration of 100 ppm.

C. Application:

1. Inject disinfecting solution into pump and associated piping and circulate for a minimum 3-hour period of time. At end of 3-hour period, solution shall have a strength of at least 50 ppm free chlorine.
2. Operate valves and pump appurtenances during disinfection to ensure disinfecting solution is dispersed into all parts of pump and lines.
3. If disinfecting solution contained in pump has a residual free chlorine concentration less than 50 ppm after the 3-hour retention period, reclean pump, reapply disinfecting solution, and retest until a satisfactory test result is obtained.
4. After chlorination, flush water from pump until water through unit is chemically and bacteriologically equal to permanent source of supply.

3.05 DISPOSAL OF CHLORINATED WATER

A. Do not allow flow into a waterway without neutralizing disinfectant residual.

B. See appendix of AWWA C653 for acceptable neutralization methods.

3.06 TESTING

A. Collection of Samples:

1. Coordinate activities to allow Samples to be taken in accordance with this Specification.

2. Provide valves at sampling points.
 3. Provide access to sampling points.
- B. Test Equipment:
1. Clean containers and equipment used in sampling and make sure they are free of contamination.
 2. Obtain sampling bottles with instructions for handling from an independent testing laboratory.
- C. Chlorine Concentration Sampling and Analysis: Collect and analyze Samples in accordance with AWWA C653.
- D. After pumps and pipelines have been cleaned, disinfected, and refilled with potable water, an independent laboratory will take water Samples and have them analyzed for conformance to bacterial limitations for public drinking water supplies.
1. Collect Samples in accordance with applicable AWWA Standard.
 2. Analyze Samples for coliform concentrations in accordance with latest edition of Standard Methods for the Examination of Water and Wastewater.
 3. Sampling points shall be representative and accepted by Engineer.
- E. If minimum Samples required above are bacterially positive, disinfecting procedures and bacteriological testing shall be repeated until bacterial limits are met.

END OF SECTION

SECTION 40 05 15
PIPING SUPPORT SYSTEMS

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American Society of Civil Engineers (ASCE): 7, Minimum Design Loads for Buildings and Other Structures.
2. American Society of Mechanical Engineers (ASME): B31.1, Power Piping.
3. ASTM International (ASTM):
 - a. A123/A123M, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
 - b. A653/A653M, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvanealed) by the Hot-Dip Process.
 - c. E84, Standard Test Method for Surface Burning Characteristics of Building Materials.
4. International Code Council (ICC):
5. International Building Code (IBC).
6. International Mechanical Code (IMC).
7. Manufacturers' Standardization Society (MSS):
 - a. SP 58, Pipe Hangers and Supports—Materials, Design and Manufacture.
 - b. SP 127, Bracing for Piping Systems Seismic-Wind-Dynamic Design, Selection, and Application.

1.02 DEFINITIONS

A. Wetted or Submerged: Submerged, less than 1 foot above liquid surface, below top of channel wall, under cover or slab of channel or tank, or in other damp locations.

1.03 SUBMITTALS

A. Action Submittals:

1. Catalog information and drawings of piping support system, locating each support, sway brace, seismic brace, hanger, guide, component, and anchor for piping. Identify support, hanger, guide, and anchor type by catalog number and Shop Drawing detail number.
2. Calculations for each type of pipe support, attachment and anchor.

3. Revisions to support systems resulting from changes in related piping system layout or addition of flexible joints.
4. Anchorage and bracing drawings and cut sheets, as required by Section 01 88 15, Anchorage and Bracing.

B. Informational Submittals:

1. Anchorage and bracing calculations as required by Section 01 88 15, Anchorage and Bracing.
2. Component and attachment testing seismic certificate of compliance as required by Section 01 45 33, Special Inspection, Observation, and Testing.
3. Maintenance information on piping support system.

1.04 QUALIFICATIONS

- A. Piping support systems shall be designed by a qualified engineer. Calculations and Shop Drawings shall be signed and sealed by a professional engineer registered in the state of Georgia.

1.05 DESIGN REQUIREMENTS

A. General:

1. Design, size, and locate piping support systems throughout facility, whether shown or not.
2. Piping Smaller than 30 Inches: Supports are shown only where specific types and locations are required; additional pipe supports may be required.
3. Piping 30 Inches and Larger: Support systems have been designed for piping shown.
4. Meet requirements of MSS SP 58 and ASME B31.1 or as modified by this section.

B. Pipe Support Systems:

1. Design pipe support systems for gravity and thrust loads imposed by weight of pipes or internal pressures, including insulation and weight of fluid in pipes.
2. Seismic loads in accordance with governing codes and as shown on Structural General Drawings.
3. Wind loads in accordance with governing codes and as shown on Structural General Drawings.

4. Maximum Support Spacing and Minimum Rod Size: In accordance MSS SP 58 Table 3 and Table 4.
 - a. Ductile-iron Pipe 8 Inches and Under: Maximum span limited to that for standard weight steel pipe for water service.
 - b. Ductile-iron Pipe 10 Inches and Larger: Maximum span limited to 20 feet.
 5. Electrical Conduit Support: Include in design of framing support system.
- C. Anchoring Devices: Design, size, and space support anchoring devices, including anchor bolts, inserts, and other devices used to anchor support, to withstand shear and pullout loads imposed by loading and spacing on each particular support.
- D. Vertical Sway Bracing: 10-foot maximum centers or as shown.
- E. Existing Support Systems: Use existing supports systems to support new piping only if Contractor can show they are adequate for additional load, or if they are strengthened to support additional load.

PART 2 PRODUCTS

2.01 GENERAL

- A. When specified items are not available, fabricate pipe supports of correct material and to general configuration indicated.
- B. Special support and hanger details may be required for cases where standard catalog supports are not applicable.
- C. Materials: In accordance with Table 1 and Table 2, attached as Supplements at end of section.

2.02 HANGERS

- A. Clevis: MSS SP 58, Type 1:
 1. Anvil; Figure 260 for steel pipe and Figure 590 for ductile-iron pipe, sizes 1/2 inch through 30 inches.
 2. Insulated Steel Pipe: Anvil; Figure 260 with insulated saddle system (ISS), sizes 1/2 inch through 16 inches.
 3. B-Line; Figure B3100, sizes 1/2 inch through 30 inches.
- B. Adjustable Swivel Split-Ring Pipe Clamp: MSS SP 58, Type 6:
 1. Anvil; Figure 104, sizes 3/4 inch through 8 inches.
 2. B-Line; Figure B3171, sizes 3/4 inch through 8 inches.

- C. Steel Yoke Pipe Rolls and Roller Supports: MSS SP 58, Type 41 or Type 43:
 - 1. Anvil; Figure 181 for sizes 2-1/2 inches through 24 inches, and Figure 171 for sizes 1 inch through 30 inches.
 - 2. B-Line; Figure B3110 for sizes 2 inches through 24 inches and Figure B3114 for 30 inches.
- D. Pipe Rollers and Supports: MSS SP 58, Type 44:
 - 1. Anvil; Figure 175, sizes 2 inches through 30 inches.
 - 2. B-Line; Figure B3120, sizes 2 inches through 24 inches.

2.03 WALL BRACKETS, SUPPORTS, AND GUIDES

- A. Welded Steel Wall Bracket: MSS SP 58, Type 33 (heavy-duty):
 - 1. Anvil; Figure 199, 3,000-pound rating.
 - 2. B-Line; Figure B3067, 3,000-pound rating.
- B. Adjustable “J” hanger MSS SP 58, Type 5:
 - 1. Anvil; Figure 67, sizes 1/2 inch through 8 inches.
 - 2. B-Line; Figure B3690, sizes 1/2 inch through 8 inches.
- C. Offset Pipe Clamp: Anvil; Figure 103, sizes 3/4 inch through 8 inches.
- D. Channel Type:
 - 1. Unistrut.
 - 2. Anvil; Power-Strut.
 - 3. B-Line; Strut System.
 - 4. Aickinstrut (FRP).

2.04 PIPE SADDLES

- A. Provide 90-degree to 120-degree pipe saddle for pipe 6 inches and larger with baseplates drilled for anchors bolts.
 - 1. In accordance with Standard Detail 4005-515.
 - 2. Sizes 20 inches through 60 inches, Piping Technology & Products, Inc.; Fig. 2000.

B. Saddle Supports, Pedestal Type:

1. Minimum standard weight pipe stanchion, saddle, and anchoring flange.
2. Nonadjustable Saddle: MSS SP, Type 37 with U-bolt.
 - a. Anvil; Figure 259, sizes 4 inches through 36 inches with Figure 63C base.
 - b. B-Line; Figure B3095, sizes 1 inch through 36 inches with B3088S base.
3. Adjustable Saddle: MSS SP 58, Type 38 without clamp.
 - a. Anvil; Figure 264, sizes 2-1/2 inches through 36 inches with Figure 62C base.
 - b. B-Line; Figure B3092, sizes 3/4 inch through 36 inches with Figure B3088S base.

2.05 CHANNEL TYPE SUPPORT SYSTEMS

- A. Channel Size: 12-gauge, 1-5/8-inch wide minimum steel, or 1-1/2-inch wide, minimum FRP.
- B. Members and Connections: Design for loads using one-half of manufacturer's allowable loads.
- C. Fasteners: Vinyl ester fiber, polyurethane base composite nuts and bolts, or encapsulated steel fasteners.
- D. Manufacturers and Products:
 1. B-Line; Strut System.
 2. Unistrut.
 3. Anvil; Power-Strut.
 4. Aickinstrut (FRP System).
 5. Enduro-Durostrut (FRP Systems).

2.06 FRP PIPE SUPPORTS SYSTEMS

- A. General:
 1. FRP with UV additive, protective veil, and vinyl ester resins resistance to chemicals listed in Supplement at end of section.
 2. Fire Retardant: ASTM E84.
 3. Include hangers, rods, attachments, and fasteners.
- B. Clevis Hangers:
 1. Factor of Safety: 3 to 1.
 2. Minimum Design Load: 200 pounds.

C. Design:

1. Design pipe supports spacing, hanger rod sizing based upon manufacturer's recommendations.
2. Identify and highlight nonFRP fasteners or components in Shop Drawing.

D. Manufacturers:

1. Aickinstrut.
2. Enduro.
3. Century Composite.

2.07 PIPE CLAMPS

A. Riser Clamp: MSS SP 58, Type 8.

1. Anvil; Figure 261, sizes 3/4 inch through 24 inches.
2. B-Line; Figure B3373, sizes 1/2 inch through 30 inches.

2.08 ELBOW AND FLANGE SUPPORTS

- A. Elbow with Adjustable Stanchion: Sizes 2 inches through 18 inches, Anvil; Figure 62C base.
- B. Elbow with Nonadjustable Stanchion: Sizes 2-1/2 inches through 42 inches, Anvil; Figure 63A or Figure 63B base.
- C. Flange Support with Adjustable Base: Sizes 2 inches through 24 inches, Standon; Model S89.

2.09 INTERMEDIATE PIPE GUIDES

A. Type: Hold down pipe guide.

1. Manufacturer and Product: B-Line; Figure B3552, 1-1/2 inches through 30 inches.

B. Type: U-bolts with double nuts to provide nominal 1/8-inch to 1/4-inch clearance around pipe; MSS SP 58, Type 24.

1. Anvil; Figure 137 and Figure 137S.
2. B-Line; Figure B3188 and Figure B3188NS.

2.10 PIPE ALIGNMENT GUIDES

- A. Type: Spider.
- B. Manufacturers and Products:
 - 1. Anvil; Figure 255, sizes 1/2 inch through 24 inches.
 - 2. B-Line; Figure B3281 through Figure B3287, sizes 1/2 inch through 24 inches.

2.11 PIPE ANCHORS

- A. Type: Anchor chair with U-bolt strap.
- B. Manufacturer and Product: B-Line; Figure B3147A or Figure B3147B.

2.12 SEISMIC RESTRAINTS

- A. Solid pipe bracing attachment to pipe clevis with clevis cross brace and angle rod reinforcement.
- B. Manufacturers:
 - 1. Mason Industries.
 - 2. B-Line.
 - 3. Anvil.

2.13 ACCESSORIES

- A. Anchor Bolts:
 - 1. Size and Material: Sized by Contractor for required loads, 1/2-inch minimum diameter, and as specified in Section 05 50 00, Metal Fabrications.
 - 2. Bolt Length (Extension Above Top of Nut):
 - a. Minimum Length: Flush with top of nut preferred. If not flush, shall be no more than one thread recessed below top of nut.
 - b. Maximum Length: No more than a full nut depth above top of nut.
- B. Dielectric Barriers:
 - 1. Plastic coated hangers, isolation cushion, or tape.
 - 2. Manufacturer and Products:
 - a. B-Line; B1999 Vibra Cushion.
 - b. B-Line; Iso Pipe, Isolation Tape.

C. Insulation Shields:

1. Type: Galvanized steel or stainless steel, MSS SP 58, Type 40.
2. Manufacturers and Products:
 - a. Anvil; Figure 167, sizes 1/2 inch through 24 inches.
 - b. B-Line; Figure B3151, sizes 1/2 inch through 24 inches.

D. Welding Insulation Saddles:

1. Type: MSS SP 58, Type 39.
2. Manufacturers and Products:
 - a. Anvil; Figure Series 160, sizes 1 inch through 36 inches.
 - b. B-Line; Figure Series B3160, sizes 1/2 inch through 24 inches.

E. Plastic Pipe Support Channel:

1. Type: Continuous support for plastic pipe and to increase support spacing.
2. Manufacturer and Product: B-Line; Figure Series B3106V, sizes 1/2 inch through 6 inches with Figure B3106 Vee bottom hanger.

F. Hanger Rods, Clevises, Nuts, Sockets, and Turnbuckles: In accordance with MSS SP 58.

G. Attachments:

1. I-Beam Clamp: Concentric loading type, MSS SP 58, Type 21, Type 28, Type 29, or Type 30, which engage both sides of flange.
2. Concrete Insert: MSS SP 58, Type 18, continuous channel insert with load rating not less than that of hanger rod it supports.
3. Welded Beam Attachment: MSS SP 58, Type 22.
 - a. Anvil; Figure 66.
 - b. B-Line; Figure B3083.
4. U-Channel Concrete Inserts: As specified in Section 05 50 00, Metal Fabrications.
5. Concrete Attachment Plates:
 - a. Anvil; Figure 47, Figure 49, or Figure 52.
 - b. B-Line; Figure B3084, Figure B3085, or Figure B3086.

PART 3 EXECUTION

3.01 INSTALLATION

A. General:

1. Install support systems in accordance with MSS SP 58, unless shown otherwise.
2. Install pipe hanger rods plumb, within 4 degrees of vertical during shut down, start up or operations.

3. Support piping connections to equipment by pipe support and not by equipment.
4. Support large or heavy valves, fittings, and appurtenances independently of connected piping.
5. Support no pipe from pipe above it.
6. Support pipe at changes in direction or in elevation, adjacent to flexible joints and couplings, and where shown.
7. Do not use adhesive anchors for attachment of supports to ceiling or walls.
8. Do not install pipe supports and hangers in equipment access areas or bridge crane runs.
9. Brace hanging pipes against horizontal movement by both longitudinal and lateral sway bracing and to reduce movement after startup.
10. Install lateral supports for seismic loads at changes in direction.
11. Install pipe anchors where required to withstand expansion thrust loads and to direct and control thermal expansion.
12. Repair mounting surfaces to original condition after attachments are completed.

B. Standard Pipe Supports:

1. Horizontal Suspended Piping:
 - a. Single Pipes: Clevis hangers or adjustable swivel split-ring.
 - b. Grouped Pipes: Trapeze hanger system.
2. Horizontal Piping Supported from Walls:
 - a. Single Pipes: Wall brackets, or attached to wall, or to wall mounted framing with anchors.
 - b. Stacked Piping: Wall mounted framing system and “J” hangers acceptable for pipe smaller than 3-inch.
 - c. Pipe clamp that resists axial movement of pipe through support is not acceptable. Use pipe rollers supported from wall bracket.
3. Horizontal Piping Supported from Floors:
 - a. Saddle Supports:
 - 1) Pedestal Type, elbow and flange.
 - 2) Provide minimum 1-1/2-inch grout beneath baseplate.
 - b. Floor Mounted Channel Supports:
 - 1) Use for pipe smaller than 3-inch running along floors and in trenches at pipe elevations lower than can be accommodated using pedestal pipe supports.
 - 2) Attach channel framing to floors with baseplate on minimum 1-1/2-inch nonshrink grout and with anchor bolts.
 - 3) Attach pipe to channel with clips or pipe clamps.
 - c. Concrete Cradles: Use for pipe larger than 3 inches along floor and in trenches at pipe elevations lower than can be accommodated using stanchion type.

4. Insulated Pipe:
 - a. Pipe hanger and support shall be on outside of insulation. Do not enclose within insulation.
 - b. Provide precut 120-degree sections of rigid insulation (minimum length same as shield), shields and oversized hangers or insulated saddle system (ISS).
 - c. Wall-mounted pipe clips not acceptable for insulated piping.
5. Vertical Pipe: Support with wall bracket and elbow support, or riser clamp on floor penetration.

C. Standard Attachments:

1. New Concrete Ceilings: Concrete inserts, concrete attachment plates, or concrete anchors as limited below:
 - a. Single point attachment to ceiling allowed only for 3/4-inch rod and smaller (8 inches and smaller pipe).
 - b. Where there is vibration or bending considerations, do not connect a single pipe support hanger rod directly to a drilled concrete anchor (single point attachment) regardless of size.
2. Existing Concrete Ceilings: Channel type support with minimum of two anchor points, concrete attachment plates or concrete anchors as limited below:
 - a. Single point attachment to ceiling is allowed only for 3/4-inch rod and smaller (8 inches and smaller pipe).
 - b. Where there is vibration or bending considerations do not connect a single pipe support hanger rod directly to a drilled concrete anchor (single point attachment) regardless of size.
3. Steel Beams: I-beam clamp or welded attachments.
4. Wooden Beams: Lag screws and angle clips to members not less than 2-1/2 inches thick.
5. Concrete Walls: Concrete inserts or brackets or clip angles with concrete anchors.
6. Concrete Beams: Concrete inserts, or if inserts are not used attach to vertical surface similar to concrete wall. Do not drill into beam bottom.

D. Saddles for Steel or Concrete Pipe: Provide 90-degree to 120-degree pipe saddle for pipe sizes 6 inches and larger when installed on top of steel or concrete beam or structure, pipe rack, trapeze, or where similar concentrated point supports would be encountered.

E. Intermediate and Pipe Alignment Guides:

1. Provide pipe alignment guides, or pipe supports that provide same function, at expansion joints and loops.
2. Guide pipe on each side of expansion joint or loop at 4 pipe and 14 pipe diameters from each joint or loop.

3. Install intermediate guides on metal framing support systems not carrying pipe anchor or alignment guide.

F. Accessories:

1. Insulation Shield: Install on insulated piping with oversize rollers and supports.
2. Welding Insulation Saddle: Install on insulated steel pipe with oversize rollers and supports.
3. Dielectric Barrier:
 - a. Provide between painted or galvanized carbon steel members and copper or stainless steel pipe or between stainless steel supports and nonstainless steel ferrous metal piping.
 - b. Install rubber wrap between submerged metal pipe and oversized clamps.

3.02 FIELD FINISHING

- A. Paint atmospheric exposed surfaces hot-dip galvanized steel components as specified in Section 09 90 00, Painting and Coating.

3.03 SUPPLEMENTS

- A. The supplements listed below, following “End of Section,” are a part of this Specification:
 1. Table 1: Nonchemical Areas.
 2. Table 2: Chemical Areas.

END OF SECTION

Table 1 Nonchemical Areas	
Exposure Conditions	Support Material
Chemical Areas	See Table 2
Notes: Stainless steel to be 304 (or 304L for welded).	

Table 2 Chemical Areas	
Exposure Conditions	Support Material
Chlorine Dioxide	FRP
Purate	FRP
Sulfuric Acid	Stainless Steel
Notes: Stainless steel to be 304 (or 304L for welded).	

SECTION 40 05 33 PIPE HEAT TRACING

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. Factory Mutual.
2. Institute of Electrical and Electronics engineers, Inc (IEEE): 515, Testing, Design, Installation and Maintenance of Electrical Resistance Heat Tracing for Industrial Applications.
3. National Electrical Manufacturers' Association (NEMA): 250, Enclosures for Electrical Equipment (1,000 Volts Maximum).
4. Underwriters Laboratories, Inc. (UL).

1.02 SUBMITTALS

A. Action Submittals:

1. Manufacturer's descriptive literature.
2. Plastic Pipe Installations: Output adjustment factors for heating tape for the services indicated.
3. Pipe heat loss calculations for each pipe size to be heat traced.

PART 2 PRODUCTS

2.01 SYSTEM DESIGN REQUIREMENTS

A. Design Heating Load:

1. Heating load to be calculated based upon a 50 degree F delta, 20 mph wind if pipes are located outdoors, insulation as specified in Section 40 42 13, Process Piping Insulation, pipe as specified in Section 40 27 00, Piping—General, and shall include a 10 percent safety factor.
2. See Section 43 40 02, Fiberglass Reinforced Plastic Tank for RFP tank heat trace and insulation requirements.
3. Heat loss calculations shall be based on IEEE 515, Equation 1, Page 19.

2.02 ELECTRICAL HEATING TAPE

- A. Cable: Self-limiting, parallel circuit construction consisting of continuous inner core of variable resistance conductive heating material between two parallel copper bus wires. Provide tinned copper braid for PVC, FRP, and stainless steel pipe applications.
- B. UL Listing: Listed as self-limiting pipe tracing material for pipe freeze protection application in ordinary conditions.
- C. Maximum Maintenance Temperature: 150 degrees F (65 degrees C).
- D. Maximum Intermittent Temperature: 185 degrees F (85 degrees C).
- E. Service Voltage: 120-volts.
- F. Manufacturers and Products:
 - 1. Raychem; BTV-CR.
 - 2. Thermon; BSX.
 - 3. Nelson; CL1-J1 or L1-J1.

2.03 CONNECTION SYSTEM

- A. Rating: NEMA 250, Type 4 and Factory Mutual approved.
- B. Operating Monitor Light: Furnish with each circuit power connection kit to indicate when heat tracing is energized.
- C. Manufacturers and Products:
 - 1. Power Connection Kit:
 - a. Raychem; JBS-100.
 - b. Thermon; PCA-1-SR or DP-L.
 - c. Nelson; PLT-BC.
 - 2. Splice Kit:
 - a. Raychem; S-150.
 - b. Thermon; PCS-1-SR.
 - c. Nelson; PLT-BS.
 - 3. Tee Kit:
 - a. Raychem; T-100.
 - b. Thermon; DS-S.
 - c. Nelson; PLT-BY.
 - 4. End Seal Kit:
 - a. Raychem; E-150.
 - b. Thermon; DE-S.
 - c. Nelson; LT-ME.

5. Lighted End Seal Kit:
 - a. Raychem; E-100-L.
 - b. Thermon; DLS.
 - c. Nelson; LT-L.

2.04 SECURING TAPE

A. Plastic Piping Systems:

1. Type: Aluminum foil coated adhesive tape.
2. Manufacturers and Products:
 - a. Raychem; AT-180.
 - b. Thermon; AL-20P.
 - c. Nelson; AT-50.

B. Metallic Piping Systems:

1. Type: Glass or polyester cloth pressure sensitive tape.
2. Manufacturers and Products:
 - a. Raychem; GS54 or GT66.
 - b. Thermon; PF-1.
 - c. Nelson; GT-6 or GT-60.

2.05 PIPE MOUNTED THERMOSTAT

- A. Type: Fixed, nonadjustable, set at 40 degrees F.
- B. Sensor: Fluid-filled with 3-foot capillary.
- C. Enclosure: Glass-filled nylon, NEMA 250, Type 4X weatherproof with gasketed lid.
- D. Switch: SP-ST, UL listed, rated 22 amps, 120 to 240V ac.
- E. Manufacturers and Products:
 1. Raychem; DigiTrace Model AMC-F5.
 2. Thermon; E4X-1.
 3. Raychem; DigiTrace Model E507S-LS for hazardous areas.
 4. Thermon; E7-25325 for hazardous areas.

2.06 AMBIENT THERMOSTAT

- A. Type: Adjustable setting (15 to 140 degrees F).
- B. Sensor: Fluid-filled probe.

- C. Enclosure: Epoxy-coated NEMA 250, Type 4X aluminum enclosure with exposed hardware of stainless steel.
- D. Switch: SP-DT, UL or FM listed, rated 22 amps, 125 to 250V ac.
- E. Manufacturers and Products:
 - 1. Raychem; DigiTrace Model AMC-1A.
 - 2. Thermon; B4X-15140.
 - 3. Raychem; DigiTrace Model AMC-1H for hazardous areas.
 - 4. Thermon; B7-15140 for hazardous areas.

PART 3 EXECUTION

3.01 INSTALLATION

- A. General:
 - 1. Install in accordance with the manufacturer's instructions and recommended practices.
 - 2. Provide insulation as specified in Section 40 42 13, Process Piping Insulation, over all pipe heat tracing.
 - 3. Ground metallic structures or materials used for support of heating cable or on which it is installed in accordance with applicable codes.
 - 4. Wiring between power connection points of heat tracing cable branch lines shall be provided by heat tracing system supplier.
 - 5. Provide end of circuit pilot lights on heat tracing circuits for buried piping.
- B. Electrical Heating Tape:
 - 1. Determine required length of electrical heating tape by considering length of circuit, number and type of fittings and fixtures, design heating load, and heating tape output.
 - 2. Where design heating load exceeds heating tape capacity, install by spiraling.
 - 3. Install on services as follows:
 - a. Provide on piping of this service that matches one of the following criteria:
 - 1) Pipe nominal diameter is 4 inches or less and pipe is Exposed (EXP) in an unheated or outdoor space, unless otherwise noted.

- 2) Regardless of pipe size, provide on small diameter appurtenances such as air relief valves and their associated inlet piping and vent pipe, control valve tubing, drain valve taps, sample taps, and instrument taps/pipe that is Exposed (EXP) in an unheated or outdoor space, unless otherwise noted.
 - a) Note that instrument taps that are entirely glycerin filled, no heat trace required. If a portion of the tap has service fluid in it, heat trace is required.
- b. See 40 27 00, Piping- General for pipe materials.
 - 1) Derate heating tape capacity when installed on plastic piping.
- c. Heat trace schedule:

Facility/Area	Service	Notes
20- Chlorine Dioxide System (outside only)	PUR	-On purate feed (from the tank to the generator), all exposed piping requires heat trace. -On purate tank drain, only heat trace between tank and drain valve. -On purate tank overflow, no heat trace required. -On all purate vents, no heat trace required. -On purate tank fill, no heat trace required.
	W1	-All expose W1. -No heat trace on hose bib. -Heat trace should include safety shower.

4. Install additional heating tape at bolted flanges, valves, pipe supports, and other fittings and fixtures as recommended by supplier, but not less than the following:

Item	Heating Tape Length (min. feet)
Bolted flanges (per pair)	Two times pipe diameter
Valves	Four times valve length
Pipe hanger or support penetrating insulation	Three times pipe diameter

- C. Heat Tracing Circuits: Limit individual lengths of heat tracing circuits such that maximum single circuit capacity is 20 amps when starting the circuit at 40 degrees F. Provide multiple 20-amp circuits as required at individual heat tracing locations.
- D. Thermostats:
 - 1. Install in accordance with manufacturer's instructions and as approved by Engineer.
 - 2. For each group of heat traced circuit, install one ambient thermostat.

3.02 FIELD QUALITY CONTROL

- A. Test each circuit with 500-volt insulation tester between circuit and ground with neutrals isolated from ground.
 - 1. Insulation Resistance: Minimum 1,000 megohms per 1,000 feet.

END OF SECTION

SECTION 40 27 00
PIPING—GENERAL

PART 1 GENERAL

1.01 REFERENCES

- A. The following is a list of standards which may be referenced in this section and any supplemental Data Sheets:
1. Air Force: A-A-58092, Tape, Antiseize, Polytetrafluorethylene.
 2. American Association of State Highway and Transportation Officials (AASHTO): HB-17, Standard Specifications for Highway Bridges.
 3. American Petroleum Institute (API): SPEC 5L, Specification for Line Pipe.
 4. American Society of Mechanical Engineers (ASME):
 - a. Boiler and Pressure Vessel Code, Section IX, Qualification Standard for Welding and Brazing Procedures, Welders, Brazers, and Welding and Brazing Operators.
 - b. B1.20.1, Pipe Threads, General Purpose (Inch).
 - c. B16.1, Gray Iron Pipe Flanges and Flanged Fittings Classes 25, 125, and 250.
 - d. B16.3, Malleable Iron Threaded Fittings Classes 150 and 300.
 - e. B16.5, Pipe Flanges and Flanged Fittings NPS 1/2 through NPS 24 Metric/Inch Standard.
 - f. B16.9, Factory-Made Wrought Buttwelding Fittings.
 - g. B16.11, Forged Fittings, Socket-Welding and Threaded.
 - h. B16.15, Cast Copper Alloy Threaded Fittings Classes 125 and 250.
 - i. B16.21, Nonmetallic Flat Gaskets for Pipe Flanges.
 - j. B16.22, Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
 - k. B16.24, Cast Copper Alloy Pipe Flanges and Flanged Fittings Classes 150, 300, 600, 900, 1500, and 2500.
 - l. B16.25, Buttwelding Ends.
 - m. B16.42, Ductile Iron Pipe Flanges and Flanged Fittings Classes 150 and 300.
 - n. B31.1, Power Piping.
 - o. B31.3, Process Piping.
 - p. B31.9, Building Services Piping.
 - q. B36.10M, Welded and Seamless Wrought Steel Pipe.
 5. American Society for Nondestructive Testing (ASNT): SNT-TC-1A, Recommended Practice for Personal Qualification and Certification in Nondestructive Testing.

6. American Water Works Association (AWWA):
 - a. C104/A21.4, Cement-Mortar Lining for Ductile-Iron Pipe and Fittings.
 - b. C105/A21.5, Polyethylene Encasement for Ductile-Iron Pipe Systems.
 - c. C110/A21.10, Ductile-Iron and Gray-Iron Fittings.
 - d. C111/A21.11, Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
 - e. C115/A21.15, Flanged Ductile-Iron Pipe with Ductile-Iron or Gray-Iron Threaded Flanges.
 - f. C151/A21.51, Ductile-Iron Pipe, Centrifugally Cast.
 - g. C153/A21.53, Ductile-Iron Compact Fittings.
 - h. C207, Steel Pipe Flanges for Waterworks Service, Sizes 4 In. Through 144 In. (100 mm Through 3,600 mm).
 - i. C606, Grooved and Shouldered Joints.
7. American Welding Society (AWS):
 - a. Brazing Handbook.
 - b. A5.8M/A5.8, Specification for Filler Metals for Brazing and Braze Welding.
 - c. D1.1/D1.1M, Structural Welding Code - Steel.
 - d. QC1, Standard for AWS Certification of Welding Inspectors.
8. ASTM International (ASTM):
 - a. A47/A47M, Standard Specification for Ferritic Malleable Iron Castings.
 - b. A53/A53M, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
 - c. A105/A105M, Standard Specification for Carbon Steel Forgings for Piping Applications.
 - d. A106/A106M, Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service.
 - e. A126, Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
 - f. A135/A135M, Standard Specification for Electric-Resistance-Welder Steel Pipe.
 - g. A139/A139M, Standard Specification for Electro-Fusion (Arc)–Welded Steel Pipe (NPS 4 Inches and Over).
 - h. A153/A153M, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
 - i. A181/A181M, Standard Specification for Carbon Steel Forgings, for General-Purpose Piping.
 - j. A182/A182M, Standard Specification for Forged or Rolled Alloy and Stainless Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service.
 - k. A183, Standard Specification for Carbon Steel Track Bolts and Nuts.

- l. A193/A193M, Standard Specification for Alloy-Steel and Stainless Steel Bolting for High Temperature or High Pressure Service and Other Special Purpose Applications.
- m. A194/A194M, Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both.
- n. A197/A197M, Standard Specification for Cupola Malleable Iron.
- o. A216/A216M, Standard Specification for Steel Castings, Carbon, Suitable for Fusion Welding, for High-Temperature Service.
- p. A234/A234M, Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service.
- q. A240/A240M, Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
- r. A276, Standard Specification for Stainless Steel Bars and Shapes.
- s. A269, Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service.
- t. A307, Standard Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength.
- u. A312/A312M, Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes.
- v. A320/A320M, Standard Specification for Alloy-Steel and Stainless Steel Bolting for Low-Temperature Service.
- w. A351/A351M, Standard Specification for Castings, Austenitic, for Pressure-Containing Parts.
- x. A395/A395M, Standard Specification for Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures.
- y. A403/A403M, Standard Specification for Wrought Austenitic Stainless Steel Piping Fittings.
- z. A409/A409M, Standard Specification for Welded Large Diameter Austenitic Steel Pipe for Corrosive or High-Temperature Service.
- aa. A536, Standard Specification for Ductile Iron Castings.
- bb. A563, Standard Specification for Carbon and Alloy Steel Nuts.
- cc. A587, Standard Specification for Electric-Resistance-Welded Low-Carbon Steel Pipe for the Chemical Industry.
- dd. A743/A743M, Standard Specification for Castings, Iron-Chromium, Iron-Chromium-Nickel, Corrosion Resistant, for General Application.
- ee. A744/A744M, Standard Specification for Castings, Iron-Chromium-Nickel, Corrosion Resistant, for Severe Service.
- ff. A774/A774M, Standard Specification for As-Welded Wrought Austenitic Stainless Steel Fittings for General Corrosive Service at Low and Moderate Temperatures.
- gg. A778, Standard Specification for Welded, Unannealed Austenitic Stainless Steel Tubular Products.

- hh. B32, Standard Specification for Solder Metal.
- ii. B43, Standard Specification for Seamless Red Brass Pipe, Standard Sizes.
- jj. B61, Standard Specification for Steam or Valve Bronze Castings.
- kk. B62, Standard Specification for Composition Bronze or Ounce Metal Castings.
- ll. B75/B75M, Standard Specification for Seamless Copper Tube.
- mm. B88, Standard Specification for Seamless Copper Water Tube.
- nn. B98/B98M, Standard Specification for Copper-Silicon Alloy Rod, Bar and Shapes.
- oo. B462, Standard Specification for Forged or Rolled UNS N06030, UNS N06022, UNS N06035, UNS N06200, UNS N06059, UNS N10362, UNS N06686, UNS N08020, UNS N08024, UNS N08026, UNS N08367, UNS N10276, UNS N10665, UNS N10675, UNS N10629, UNS N08031, UNS N06045, UNS N06025, and UNS R20033 Alloy Pipe Flanges, Forged Fittings, and Valves and Parts for Corrosive High-Temperature Service.
- pp. B464, Standard Specification for Welded UNS N08020 Alloy Pipe.
- qq. B474, Standard Specification for Electric Fusion Welded Nickel and Nickel Alloy Pipe.
- rr. C582, Standard Specification for Contact-Molded Reinforced Thermosetting Plastic (RTP) Laminates for Corrosion-Resistant Equipment.
- ss. D412, Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers-Tension.
- tt. D413, Standard Test Methods for Rubber Property-Adhesion to Flexible Substrate.
- uu. D543, Standard Practices for Evaluating the Resistance of Plastics to Chemical Reagents.
- vv. D1248, Standard Specification for Polyethylene Plastics Extrusion Materials for Wire and Cable.
- ww. D1330, Standard Specification for Rubber Sheet Gaskets.
- xx. D1784, Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds.
- yy. D1785, Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.
- zz. D2000, Standard Classification System for Rubber Products in Automotive Applications.
- aaa. D2310, Standard Classification for Machine-Made "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe.
- bbb. D2464, Standard Specification for Threaded Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.
- ccc. D2466, Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40.

- ddd. D2467, Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.
- eee. D2564, Standard Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems.
- fff. D2837, Standard Test Method for Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials or Pressure Design Basis for Thermoplastic Pipe Products.
- ggg. D2996, Standard Specification for Filament-Wound “Fiberglass” (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe.
- hhh. D3222, Standard Specification for Unmodified Poly(Vinylidene Fluoride) (PVDF) Molding Extrusion and Coating Materials.
- iii. D3350, Standard Specification for Polyethylene Plastics Pipe and Fittings Materials.
- jjj. D4101, Standard Specification for Polypropylene Injection and Extrusion Materials.
- kkk. D4894, Standard Specification for Polytetrafluoroethylene (PTFE) Granular Molding and Ram Extrusion Materials.
- lll. D4895, Standard Specification for Polytetrafluoroethylene (PTFE) Resin Produced from Dispersion.
- mmm. F423, Standard Specification for Polytetrafluoroethylene (PTFE) Plastic-Lined Ferrous Metal Pipe, Fittings, and Flanges.
- nnn. F436, Standard Specification for Hardened Steel Washers.
- ooo. F437, Standard Specification for Threaded Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80.
- ppp. F439, Standard Specification for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80.
- qqq. F441/F441M, Standard Specification for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe, Schedules 40 and 80.
- rrr. F493, Standard Specification for Solvent Cements for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe and Fittings.
- sss. F593, Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.
- ttt. F656, Standard Specification for Primers for Use in Solvent Cement Joints of Poly(Vinyl Chloride) (PVC) Plastic Pipe and Fittings.
- 9. FM Global (FM).
- 10. Manufacturers Standardization Society of the Valve and Fittings Industry, Inc. (MSS): SP-43, Wrought and Fabricated Butt-Welding Fittings for Low-Pressure, Corrosion Resistant Applications.
- 11. NSF International (NSF):
 - a. ANSI 61: Drinking Water System Components - Health Effects.
 - b. ANSI 372: Drinking Water System Components - Lead Content.
- 12. National Electrical Manufacturers Association (NEMA): LI 1, Industrial Laminating Thermosetting Products.
- 13. National Fire Protection Association (NFPA): 24, Standard for the Installation of Private Fire Service Mains and Their Appurtenances.

1.02 DEFINITIONS

A. Submerged or Wetted:

1. Zone below elevation of:
 - a. Top face of channel walls and cover slabs.
 - b. Liquid surface or within 1 foot above top of liquid surface.
 - c. Top of tank wall or under tank cover.

1.03 DESIGN REQUIREMENTS

A. Where pipe diameter, thickness, pressure class, pressure rating, or thrust restraint is not shown or specified, design piping system in accordance with the following:

1. Process Piping: ASME B31.3, normal fluid service unless otherwise specified.
2. Building Service Piping: ASME B31.9, as applicable.
 - a. Sanitary Building Drainage and Vent Systems: ICC International Plumbing Code.
3. Buried Piping: H20-S16 traffic load with 1.5 impact factor, AASHTO HB-17, as applicable.
4. Thrust Restraints:
 - a. Design for test pressure shown in Piping Schedule.
 - b. Allowable Soil Pressure: 1,000 pounds per square foot.
 - c. Low Pressure Pipelines:
 - 1) When bearing surface of the fitting against soil provides an area equal to or greater than area required for thrust restraint, concrete thrust blocks will not be required.
 - 2) Determine bearing area for fittings without thrust blocks by projected area of 70 percent of internal diameter multiplied by chord length for fitting centerline curve.

1.04 SUBMITTALS

A. Action Submittals:

1. Shop Fabricated Piping:
 - a. Detailed pipe fabrication or spool drawings showing special fittings and bends, dimensions, coatings, and other pertinent information.
 - b. Layout drawing showing location of each pipe section and each special length; number or otherwise designate laying sequence on each piece.

2. Pipe Wall Thickness: Identify wall thickness and rational method or standard applied to determine wall thickness for each size of each different service including exposed, submerged, buried, and concrete-encased installations for Contractor-designed piping.
3. Hydraulic Thrust Restraint for Restrained Joints: Details including materials, sizes, assembly ratings, and pipe attachment methods.
4. Thrust Blocks: Concrete quantity, bearing area on pipe, and fitting joint locations.
5. Dissimilar Buried Pipe Joints: Joint types and assembly drawings.
6. Pipe Corrosion Protection: Product data.
7. Anchorage and bracing drawings and cut sheets, as required by Section 01 88 15, Anchorage and Bracing.

B. Informational Submittals:

1. Manufacturer's Certification of Compliance, in accordance with Section 01 61 00, Common Product Requirements:
 - a. Pipe and fittings.
 - b. Factory applied resins and coatings.
2. Anchorage and bracing calculations as required by Section 01 88 15, Anchorage and Bracing.
3. Flanged Pipe and Fittings: Manufacturer's product data sheets for gaskets including torquing requirements and bolt tightening procedures.
4. Qualifications:
 - a. Nondestructive Testing Personnel: SNT-TC-1A Level II certification and qualifications.
 - b. AWS QC1 Certified Welding Inspector: Submit evidence of current certification prior to commencement of welding activities.
 - c. Welders:
 - 1) Continuity log for welders and welding operators.
 - 2) Welder qualification test records conducted by Contractor or manufacturer.
5. Welding Procedures: Qualified in accordance with ASME Boiler and Pressure Vessel Code, Section IX for weld type(s) and base metal(s).
6. Nondestructive inspection and testing procedures.
7. Test logs.
8. Pipe coating applicator certification.
9. Laboratory Testing Equipment: Certified calibrations, manufacturer's product data, and test procedures.
10. CWI inspection records and NDE test records.
11. Component and attachment testing seismic certificate of compliance as required by Section 01 45 33, Special Inspection, Observation, and Testing.

1.05 QUALITY ASSURANCE

A. Qualifications:

1. Independent Inspection and Testing Agency:
 - a. Ten years' experience in field of welding and welded pipe and fittings' testing required for this Project.
 - b. Calibrated instruments and equipment, and documented standard procedures for performing specified testing.
 - c. Certified in accordance with ASNT SNT-TC-1A for testing procedures required for this Project.
 - d. Testing Agency: Personnel performing tests shall be NDT Level II certified in accordance with ASNT SNT-TC-1A.
 - e. Verification Welding Inspector: AWS QC1 Certified.
2. Welding Procedures: In accordance with ASME BPVC SEC IX (Forms QW-482 and QW-483) or AWS D1.1/D1.1M (Annex N Forms).
3. Welder Qualifications: In accordance ASME BPVC SEC IX (Form QW-484) or AWS D1.1/D1.1M (Annex N Forms).
4. Contractor's CWI: Certified in accordance with AWS QC1, and having prior experience with specified welding codes. Alternate welding inspector qualifications require approval by Engineer.

B. Quality Assurance: Provide services of Special inspection to be provided by Owner and performed by independent inspection and testing agency for welding operations.

1. Note, the presence of Owner's Special Inspector or Verification CWI does not relieve Contractor from performing own quality control, including 100 percent visual inspection of welds.

1.06 DELIVERY, STORAGE, AND HANDLING

A. In accordance with Section 01 61 00, Common Product Requirements, and:

1. Flanges: Securely attach metal, hardboard, or wood protectors over entire gasket surface.
2. Threaded or Socket Welding Ends: Fit with metal, wood, or plastic plugs or caps.
3. Linings and Coatings: Prevent excessive drying.
4. Cold Weather Storage: Locate products to prevent coating from freezing to ground.
5. Handling: Use heavy canvas or nylon slings to lift pipe and fittings.

PART 2 PRODUCTS

2.01 GENERAL

- A. Components and Materials in Contact with Water for Human Consumption: Comply with the requirements of the Safe Drinking Water Act and other applicable federal, state, and local requirements. Provide certification by manufacturer or an accredited certification organization recognized by the Authority Having Jurisdiction that components and materials comply with the maximum lead content standard in accordance with NSF/ANSI 61 and NSF/ANSI 372.
 - 1. Use or reuse of components and materials without a traceable certification is prohibited.

2.02 PIPING

- A. As specified on Piping Data Sheet(s) and Piping Schedule located at the end of this section as Supplement.
- B. Diameters Shown:
 - 1. Standardized Products: Nominal size.

2.03 JOINTS

- A. Grooved End System:
 - 1. Rigid type.
 - 2. Use of flexible grooved joints allowed where shown on Drawings or with prior approval by Engineer.
 - 3. Flanges: When required, furnish with grooved type flange adapters of same manufacturer as grooved end couplings.
- B. Flanged Joints:
 - 1. Flat-faced, carbon steel, or alloy flanges when mating with flat-faced cast or ductile iron flanges.
 - 2. Higher pressure rated flanges as required to mate with equipment when equipment flange is of higher pressure rating than required for piping.
- C. Threaded Joints: NPT taper pipe threads in accordance with ASME B1.20.1.
- D. Flexible Mechanical Compression Joint Coupling:
 - 1. Stainless steel, ASTM A276, Type 305 bands.
 - 2. Manufacturers:
 - a. Pipeline Products Corp.
 - b. Fernco Joint Sealer Co.

2.04 GASKET LUBRICANT

- A. Lubricant shall be supplied by pipe manufacturer and no substitute or “or-equal” will be allowed.

2.05 PIPE CORROSION PROTECTION

- A. Coatings: See Section 09 90 00, Painting and Coating, for details of coating requirements.
- B. Insulating Flanges, Couplings, and Unions:
 - 1. Materials:
 - a. In accordance with applicable piping material specified in Pipe Data Sheet. Complete assembly shall have ASME B31.3 working pressure rating equal to or higher than that of joint and pipeline.
 - b. Galvanically compatible with piping.
 - c. Resistant for intended exposure, operating temperatures, and products in pipeline.
 - 2. Union Type, 2 Inches and Smaller:
 - a. Screwed or solder-joint.
 - b. O-ring sealed with molded and bonded insulation to body.
 - 3. Flange Type, 2-1/2 Inches and Larger:
 - a. Flanged, complete with bolt insulators, dielectric gasket, bolts, and nuts.
 - b. Bolt insulating sleeves shall be provided full length between insulating washers.
 - c. Ensure fit-up of components of insulated flange assembly to provide a complete functioning installation.
 - d. AWWA C207 steel flanges may be drilled oversize up to 1/8-inch to accommodate insulating sleeves.
 - e. No less than minimum thread engagement in accordance with specified bolting standards will be permitted to accommodate thicknesses of required washers, flanges, and gasket.
 - 4. Flange Insulating Kits:
 - a. Gaskets: Full-face, Type E with elastomeric sealing element. Sealing element shall be retained in a groove within retainer portion of gasket.
 - b. Insulating Sleeves: Full-length mylar.
 - c. Insulating Washers: High-strength phenolic.
 - d. Steel Washers: Plated, hot-rolled steel, 1/8 inch thick.
 - 1) Flange Diameters 36 Inches or Less: Provide two washers per bolt.
 - 2) Flange Diameters Larger Than 36 Inches: Provide four washers per bolt.

5. Manufacturers and Products:
 - a. Dielectric Flanges and Unions:
 - 1) PSI, Houston, TX.
 - 2) Advance Products and Systems, Lafayette, LA.
 - b. Insulating Couplings:
 - 1) Dresser; STAB-39.
 - 2) Baker Coupling Company, Inc.; Series 216.

2.06 VENT AND DRAIN VALVES

- A. Pipeline 2-Inch Diameter and Smaller: 1/2-inch vent, 1-inch drain, unless shown otherwise.
- B. Pipelines 2-1/2-Inch Diameter and Larger: 3/4-inch vent, 1-inch drain, unless shown otherwise.

2.07 FABRICATION

- A. Mark each pipe length on outside with the following:
 1. Size or diameter and class.
 2. Manufacturer's identification and pipe serial number.
 3. Location number on laying drawing.
 4. Date of manufacture.
- B. Code markings according to approved Shop Drawings.
- C. Shop fabricate flanged pipe in shop, not in field, and delivered to Site with flanges in place and properly faced. Threaded flanges shall be individually fitted and machine tightened on matching threaded pipe by manufacturer.

2.08 FINISHES

- A. Factory prepare, prime, and finish coat in accordance with Pipe Data Sheet(s) and Piping Schedule.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify size, material, joint types, elevation, horizontal location, and pipe service of existing pipelines to be connected to new pipelines or new equipment.
- B. Inspect size and location of structure penetrations to verify adequacy of wall pipes, sleeves, and other openings.

3.02 PREPARATION

- A. See Piping Schedule and Section 09 90 00, Painting and Coating, for additional requirements.
- B. Notify Engineer at least 2 weeks prior to field fabrication of pipe or fittings.
- C. Inspect pipe and fittings before installation, clean ends thoroughly, and remove foreign matter and dirt from inside.
- D. Damaged Coatings and Linings: Repair using original coating and lining materials in accordance with manufacturer's instructions.

3.03 WELDING

- A. Perform in accordance with Section IX, ASME Boiler and Pressure Vessel Code and ASME B31.3 for Pressure Piping, as may be specified on Piping Data Sheets, and if recommended by piping or fitting manufacturer.
- B. Weld Identification: Keep paper record of which welder welded each joint.
- C. Pipe End Preparation:
 - 1. Machine Shaping: Preferred.
 - 2. Oxygen or Arc Cutting: Smooth to touch, true, and slag removal by chipping or grinding.
 - 3. Beveled Ends for Butt Welding: ASME B16.25.
- D. Surfaces:
 - 1. Clean and free of paint, oil, rust, scale, slag, or other material detrimental to welding.
 - 2. Thoroughly clean each layer of deposited weld metal, including final pass, prior to deposition of each additional layer of weld metal with a power-driven wire brush.
- E. Alignment and Spacing:
 - 1. Align ends to be joined within existing commercial tolerances on diameters, wall thicknesses, and out-of-roundness.
 - 2. Root Opening of Joint: As stated in qualified welding procedure.
 - 3. Minimum Spacing of Circumferential Butt Welds: Minimum four times pipe wall thickness or 1 inch, whichever is greater.
- F. Climatic Conditions: Do not perform welding if there is impingement of any rain, snow, sleet, or wind exceeding 5 mph on the weld area, or if ambient temperature is below 32 degrees F.

- G. Tack Welds: Performed by qualified welder using same procedure as for completed weld, made with electrode similar or equivalent to electrode to be used for first weld pass, and not defective. Remove those not meeting requirements prior to commencing welding procedures.
- H. Surface Defects: Chip or grind out those affecting soundness of weld.
- I. Weld Quality: Meet requirements of governing welding codes.

3.04 INSTALLATION—GENERAL

- A. Join pipe and fittings in accordance with manufacturer's instructions, unless otherwise shown or specified.
- B. Remove foreign objects prior to assembly and installation.
- C. Flanged Joints:
 - 1. Install perpendicular to pipe centerline.
 - 2. Bolt Holes: Straddle vertical centerlines, aligned with connecting equipment flanges or as shown.
 - 3. Use torque-limiting wrenches to ensure uniform bearing and proper bolt tightness.
 - 4. Plastic Flanges: Install annular ring filler gasket at joints of raised-face flange.
 - 5. Grooved Joint Flange Adapters: Include stainless steel washer plates as required for mating to serrated faces and lined valves and equipment.
 - 6. Raised-Face Flanges: Use flat-face flange when joining with flat-faced ductile or cast iron flange.
 - 7. Verify compatibility of mating flange to adapter flange gasket prior to selecting grooved adapter flanging.
 - 8. Flange fillers are to be avoided, but if necessary, may be used to make up for small angles up to 6 degrees and for filling gaps up to 2 inches between flanges. Stacked flange fillers shall not be used.
 - 9. Threaded flanged joints shall be shop fabricated and delivered to Site with flanges in-place and properly faced.
 - 10. Manufacturer: Same as pipe manufacturer or grooved joint flange adapter manufacturer.
- D. Threaded and Coupled Joints:
 - 1. Conform to ASME B1.20.1.
 - 2. Produce sufficient thread length to ensure full engagement when screwed home in fittings.
 - 3. Countersink pipe ends, ream and clean chips and burrs after threading.
 - 4. Make connections with not more than three threads exposed.
 - 5. Lubricate male threads only with thread lubricant or tape as specified on Piping Data Sheets.

E. Grooved-End Joints:

1. Piping shall be grooved in accordance with manufacturer's latest published instructions and shall be accurately cut with tools conforming to coupling manufacturer's standards and to AWWA C606.
2. Install grooved joint couplings and gaskets in accordance with manufacturer's latest published installation instructions.

F. Soldered Joints:

1. Use only solder specified for particular service.
2. Cut pipe ends square and remove fins and burrs.
3. After thoroughly cleaning pipe and fitting of oil and grease using solvent and emery cloth, apply noncorrosive flux to the male end only.
4. Wipe excess solder from exterior of joint before hardened.
5. Before soldering, remove stems and washers from solder joint valves.

G. Pipe Connections at Concrete Structures: As specified in Article Piping Flexibility Provisions in Section 40 27 01, Process Piping Specialties.

H. PVC and CPVC Piping:

1. Provide Schedule 80 threaded nipple where necessary to connect to threaded valve or fitting.
2. Use strap wrench for tightening threaded plastic joints. Do not overtighten fittings.
3. Do not thread Schedule 40 pipe.

3.05 INSTALLATION—EXPOSED PIPING

A. Piping Runs:

1. Parallel to building or column lines and perpendicular to floor, unless shown otherwise.
2. Piping upstream and downstream of flow measuring devices shall provide straight lengths as required for accurate flow measurement.

B. Supports: As specified in Section 40 05 15, Piping Support Systems.

C. Group piping wherever practical at common elevations; install to conserve building space and not interfere with use of space and other work.

D. Unions or Flanges: Provide at each piping connection to equipment or instrumentation on equipment side of each block valve to facilitate installation and removal.

- E. Install piping so that no load or movement in excess of that stipulated by equipment manufacturer will be imposed upon equipment connection; install to allow for contraction and expansion without stressing pipe, joints, or connected equipment.
- F. Piping clearance, unless otherwise shown:
 - 1. Over Walkway and Stairs: Minimum of 7 feet 6 inches, measured from walking surface or stair tread to lowest extremity of piping system including flanges, valve bodies or mechanisms, insulation, or hanger/support systems.
 - 2. Between Equipment or Equipment Piping and Adjacent Piping: Minimum 3 feet, measured from equipment extremity and extremity of piping system including flanges, valve bodies or mechanisms, insulation, or hanger/support systems.
 - 3. From Adjacent Work: Minimum 1 inch from nearest extremity of completed piping system including flanges, valve bodies or mechanisms, insulation, or hanger/support systems.
 - 4. Do not route piping in front of or to interfere with access ways, ladders, stairs, platforms, walkways, openings, doors, or windows.
 - 5. Headroom in front of openings, doors, and windows shall not be less than the top of the opening.
 - 6. Do not install piping containing liquids or liquid vapors in transformer vaults or electrical equipment rooms.
 - 7. Do not route piping over, around, in front of, in back of, or below electrical equipment including controls, panels, switches, terminals, boxes, or other similar electrical work.

3.06 INSTALLATION—BURIED PIPE

- A. Joints:
 - 1. Dissimilar Buried Pipes:
 - a. Provide flexible mechanical compression joints for pressure pipe.
 - b. Provide concrete closure collar for gravity and low pressure (maximum 10 psi) piping or as shown.
 - 2. Concrete Encased or Embedded Pipe: Do not encase joints in concrete, unless specifically shown.
- B. Placement:
 - 1. Keep trench dry until pipe laying and joining are completed.
 - 2. Pipe Base and Pipe Zone: As specified in Section 31 23 23.15, Trench Backfill.
 - 3. Exercise care when lowering pipe into trench to prevent twisting or damage to pipe.
 - 4. Measure for grade at pipe invert, not at top of pipe.

5. Excavate trench bottom and sides of ample dimensions to permit visual inspection and testing of entire flange, valve, or connection.
6. Prevent foreign material from entering pipe during placement.
7. Close and block open end of last laid pipe section when placement operations are not in progress and at close of day's work.
8. Lay pipe upgrade with bell ends pointing in direction of laying.
9. Install closure sections and adapters for gravity piping at locations where pipe laying changes direction.
10. Deflect pipe at joints for pipelines laid on a curve using unsymmetrical closure of spigot into bell. If joint deflection of standard pipe lengths will not accommodate horizontal or vertical curves in alignment, provide:
 - a. Shorter pipe lengths.
 - b. Special mitered joints.
 - c. Standard or special fabricated bends.
11. After joint has been made, check pipe alignment and grade.
12. Place sufficient pipe zone material to secure pipe from movement before next joint is installed.
13. Prevent uplift and floating of pipe prior to backfilling.

C. PVC, CPVC Pipe Placement:

1. Lay pipe snaking from one side of trench to other.
2. Offset: As recommended by manufacturer for maximum temperature variation between time of solvent welding and during operation.
3. Do not lay pipe when temperature is below 40 degrees F, or above 90 degrees F when exposed to direct sunlight.
4. Shield ends to be joined from direct sunlight prior to and during the laying operation.

D. Tolerances:

1. Deflection From Vertical Grade: Maximum 1/4 inch.
2. Joint Deflection: Maximum of 75 percent of manufacturer's recommendation.
3. Horizontal position of pipe centerline on alignment around curves maximum variation of 1.75 feet from position shown.
4. Pipe Cover: Minimum 3 feet, unless otherwise shown.

3.07 PIPE CORROSION PROTECTION

- A. PVC and CPVC Pipe, Exposed: As specified in Section 09 90 00, Painting and Coating.

B. Piping Accessories:

1. Exposed:
 - a. Field paint black and galvanized steel, brass, copper, and bronze piping components as specified in Section 09 90 00, Painting and Coating, as applicable to base metal material.
 - b. Accessories include, but are not limited to, pipe hangers, supports, expansion joints, pipe guides, flexible couplings, vent and drain valves, and fasteners.
2. Buried:
 - a. Ferrous Metal and Stainless Steel Components: Coat with coal-tar epoxy as specified in Section 09 90 00, Painting and Coating.
 - b. Bolts, Nuts, and Similar Items: Coat with bituminous paint.
 - c. Flexible Couplings, Grooved Couplings, and Similar Items: Wrap with heat shrink wrap.
 - d. Buried Valves and Similar Elements on Wrapped Pipelines: Coat with bituminous paint and wrap entire valve in polyethylene encasement.

C. Polyethylene Encasement: Install in accordance with AWWA C105/A21.5 and manufacturer's instructions.

D. Tape Coating System: As specified in Section 09 90 00, Painting and Coating.

E. Heat Shrink Wrap: Apply in accordance with manufacturer's instructions to surfaces that are cleaned, prepared, and primed.

F. Insulating Flanges, Couplings, and Unions:

1. Applications:
 - a. Dissimilar metal piping connections.
 - b. Cathodically protected piping penetration to buildings and watertight structures.
 - c. Submerged to unsubmerged metallic piping connections.
 - d. Connections to existing metallic pipe.
 - e. Where required for electrically insulated connection.
2. Pipe Installation:
 - a. Submerged carbon steel, ductile iron, or galvanized piping in reinforced concrete shall be isolated from the concrete reinforcement steel.
 - b. Align and install insulating joints as shown on the Drawings and according to manufacturer's recommendations. Bolt lubricants that contain graphite or other metallic or electrically conductive components that can interfere with the insulating capabilities of the completed flange shall not be used.

3.08 THRUST RESTRAINT

A. Location:

1. Buried Piping: At all joints in piping.
2. Exposed Piping: At all joints in piping.

B. Thrust Ties:

1. Flanged Coupling Adapters: For exposed installations, install manufacturer's anchor studs through coupling sleeve or use dismantling joints.

3.09 SLAB, FLOOR, WALL, AND ROOF PENETRATIONS

- #### A. Application and Installation: As specified in Section 40 27 01, Process Piping Specialties.

3.10 BRANCH CONNECTIONS

- #### A. Do not install branch connections smaller than 1/2-inch nominal pipe size, including instrument connections, unless shown otherwise.
- #### B. When line of lower pressure connects to a line of higher pressure, requirements of Piping Data Sheet for higher pressure rating prevails up to and including first block valve in the line carrying the lower pressure, unless otherwise shown.
- #### C. Threaded Pipe Tap Connections:
1. Ductile Iron Piping: Connect only with service saddle or at tapping boss of a fitting, valve body, or equipment casting.
 2. Welded Steel or Alloy Piping: Connect only with welded threadolet or half-coupling as specified on Piping Data Sheet.
 3. Limitations: Threaded taps in pipe barrel are unacceptable.

3.11 VENTS AND DRAINS

- #### A. Vents and drains at high and low points in piping required for completed system may or may not be shown. Install vents on high points and drains on low points of pipelines.

3.12 INSULATION

- #### A. See Section 40 42 13, Process Piping Insulation.

3.13 HEAT TRACING

- A. See Section 40 05 33, Pipe Heat Tracing.

3.14 DISINFECTION

- A. See Section 33 13 00, Disinfecting of Water Utility Distribution.

3.15 FIELD FINISHING

- A. Notify Engineer at least 3 days prior to start of surface preparation or coating application work.
- B. As specified in Section 09 90 00, Painting and Coating.

3.16 PIPE IDENTIFICATION

- A. As specified in Sections 10 14 00, Signage, 09 90 00, Painting and Coating.

3.17 FIELD QUALITY CONTROL

- A. Pressure Leakage Testing: As specified in Section 40 80 01, Process Piping Leakage Testing.
- B. Minimum Duties of Welding Inspector:
 - 1. Job material verification and storage.
 - 2. Qualification of welders.
 - 3. Certify conformance with approved welding procedures.
 - 4. Maintenance of records and preparation of reports in a timely manner.
 - 5. Notification to Engineer of unsatisfactory weld performance within 24 hours of weld test failure.
- C. Required Weld Examinations:
 - 1. Perform examinations in accordance with Piping Code ASME B31.3 for Normal Fluid Service except that 5 percent of circumferential butt welds shall be random radiographed.
 - 2. Perform examinations for every pipe thickness and for each welding procedure, progressively, for piping covered by this section.
 - 3. Examine at least one of each type and position of weld made by each welder or welding operator.
 - 4. For each weld found to be defective under the acceptance standards or limitations on imperfections contained in the applicable Piping Code, examine two additional welds made by the same welder that produced the defective weld. Such additional examinations are in addition to the minimum required above. Examine, progressively, two additional welds for each tracer examination found to be unsatisfactory.

3.18 CLEANING

- A. Following assembly and testing, and prior to disinfection and final acceptance, flush pipelines, except as stated below, with water at 2.5 fps minimum flushing velocity until foreign matter is removed.
- B. Insert cone strainers in flushing connections to attached equipment and leave in-place until cleaning is complete.
- C. Remove accumulated debris through drains 2 inches and larger or by removing spools and valves from piping.

3.19 SUPPLEMENTS

- A. The supplements listed below, following “End of Section,” are a part of this Specification:
 - 1. Piping Schedule.
 - 2. Data Sheets.

Number	Title
40 27 00.10	Polyvinyl Chloride (PVC) Pipe and Fittings
40 27 00.11	Chlorinated Polyvinyl Chloride (CPVC) Pipe and Fittings

END OF SECTION

PIPING SCHEDULE

Service	Legend	Size (In.) ¹	Exposure ²	Piping Material ³	Specification Section	Joint Type ⁴	Test Pressure and Type ⁵ (psig-Type)	Pipe Color, Label ^{6,7}	Remarks
Chlorine Dioxide	CLO2	<=2	EXP	CPVC	40 27 00.11	W	100-H	Safety Yellow, CLO2	
Drain (Process)	DR	< 4	BUR/ENC	CPVC	40 27 00.11	W	G	N/A	
Drain (Process)	DR	< 4	EXP	CPVC	40 27 00.11	W	G	Light Brown, DR	
Purate	PUR	<=2	EXP	CPVC	40 27 00.11	W	15-H	Gray, Purate	
Purate	PUR	<=2	BUR/SUB	CPVC	40 27 00.11	W	15-H	N/A	
Roof Drain	RD	6	EXP	PVC	40 27 00.10	W	G	NA	
Sulfuric Acid	SU	<=2	BUR/ENC	CPVC	40 27 00.11	W	15-H	N/A	
Sulfuric Acid	SU	<=2	EXP	CPVC	40 27 00.11	W	15-H	Safety Yellow with Safety Red Bands, SU	
Vent	V	<=6	EXP	CPVC	40 27 00.11	W	N/A	Federal Safety Yellow, Vent	
Water, Potable	W1	<=2	EXP	PVC	40 27 00.10	W	175-H	Blue, W1	
Water, Potable	W1	<=2	BUR/ENC	PVC	40 27 00.10	W	175-H	N/A	
Water, Non Potable	W2	<=2	EXP	PVC	40 27 00.10	W	175-H	Blue, W2	
Water, Non Potable	W2	<=2	BUR/ENC	PVC	40 27 00.10	W	175-H	N/A	

NOTES:

1. > - Greater than, < - Less than, >= - Greater than or equal to; <= - Less than or equal to

2. BUR – Buried; ENC – Concrete encased; EXP – Exposed, either inside or outside; SUB – Submerged

3. PVC- Polyvinyl chloride; CPVC- Chlorinated polyvinyl chloride; CLDI- Cement mortar-lined ductile iron; SST- Stainless Steel; COP- Copper; RCP - Reinforced Concrete Pipe; HDPE - High Density Polyethylene

4. FL – Flanged; PRJ – Proprietary Restrained; W – Welding including solvent and fusion, flanged and screwed connections may be provided at valves/equipment and as needed to minimize field welding of SST; S-Screwed; GR-Grooved; HU- Hub and Spigot

5. G- Gravity, test to highest liquid level pipe can be subject to; H-Hydrostatic; I-In service; P- Pneumatic; PC- Test per Uniform Plumbing Code; NA-Not applicable

6. Color code applies to expose piping only. Buried or submerged piping need not conform to the color description except where noted.

7. Coating system number as specified in Section 09 90 00, Painting and Coatings and as specified in Article Pipe Corrosion Protection. Color to match existing piping of the same process.

SECTION 40 27 00.10 POLYVINYL CHLORIDE (PVC) PIPE AND FITTINGS		
Item	Size	Description
General	All	Materials in contact with potable water shall conform to NSF 61 acceptance.
Pipe	All	Schedule 80 PVC: Type I, Grade I or Class 12454-B conforming to ASTM D1784 and ASTM D1785. Pipe shall be manufactured with titanium dioxide for ultraviolet protection. Threaded Nipples: Schedule 80 PVC.
Fittings	All	Schedule to Match Pipe Above: ASTM D2466 and ASTM D2467 for socket weld type and Schedule 80 ASTM D2464 for threaded type. Fittings shall be manufactured with titanium dioxide for ultraviolet protection.
Joints	All	Solvent socket weld except where connection to threaded valves and equipment may require future disassembly.
Flanges	All	One-piece, molded hub type PVC flat face flange in accordance with Fittings above, ASME B16.1, Class 125 drilling
Bolting	All	Flat Face Mating Flange and In Corrosive Areas: ASTM A193/A193M, Type 316 stainless steel Grade B8M hex head bolts, ASTM A194/A194M Grade 8M hex head nuts and ASTM F436 Type 3 alloy washers at nuts and bolt heads. Achieve 40 percent to 60 percent of bolt minimum yield stress. With Raised Face Mating Flange: Carbon steel ASTM A307 Grade B square head bolts, ASTM A563 Grade A heavy hex head nuts and ASTM F436 hardened steel washers at nuts and bolt heads. Achieve 40 percent to 60 percent of bolt minimum yield stress.
Gaskets	All	Flat Face Mating Flange: Full faced 1/8-inch-thick ethylene propylene (EPR) rubber. Raised Face Mating Flange: Flat ring 1/8-inch ethylene propylene (EPR) rubber, with filler gasket between OD of raised face and flange OD to protect the flange from bolting moment.

SECTION 40 27 00.10 POLYVINYL CHLORIDE (PVC) PIPE AND FITTINGS		
Item	Size	Description
Solvent Cement	All	Socket type joints shall be made employing solvent cement that meets or exceeds the requirements of ASTM D2564 and primer that meets or exceeds requirements of ASTM F656, chemically resistant to the fluid service, and as recommended by pipe and fitting manufacturer, except solvent weld cement for PVC pipe joints in sodium hypochlorite service shall be free of silica filler and shall be certified by the manufacturer to be suitable for that service, IPS Weld-On 724 or approved equal. Certification shall be submitted. Solvent cement and primer shall be listed by NSF 61 for contact with potable water.
Thread Lubricant	All	Teflon Tape.

END OF SECTION

SECTION 40 27 00.11 CHLORINATED POLYVINYL CHLORIDE (CPVC) PIPE AND FITTINGS		
Item	Size	Description
Pipe	All	Schedule 80 CPVC: Type IV, Grade I or Class 23447-B conforming to ASTM D1784 and ASTM F441/F441M. Pipe shall be manufactured with titanium dioxide for ultraviolet protection. Threaded nipples shall be Schedule 80.
Fittings	All	Schedule to Match Pipe Above: Conforming to the requirements of ASTM F439 for socket weld type and Schedule 80 ASTM F437 for threaded type. Fittings shall be manufactured with titanium dioxide for ultraviolet protection.
Joints	All	Solvent socket weld except where connection to threaded valves and equipment may require future disassembly.
Flanges	All	One piece, molded hub Type CPVC flat face flange in accordance with Fittings above; ASME B16.1, Class 125 drilling.
Bolting	All	Flat Face Mating Flange and In Corrosive Areas: ASTM A193/A193M, Type 316 stainless steel Grade B8M hex head bolts, ASTM A194/A194M Grade 8M hex head nuts and ASTM F436 Type 3 alloy washers at nuts and bolt heads. Achieve 40 percent to 60 percent of bolt minimum yield stress. Raised Face Mating Flange: Carbon steel ASTM A307 Grade B square head bolts, ASTM A563 Grade A heavy hex head nuts and ASTM F436 hardened steel washers at nuts and bolt heads. Achieve 40 percent to 60 percent of bolt minimum yield stress.
Gaskets	All	Flat Face Mating Flange: Full faced 1/8-inch-thick ethylene propylene (EPR) rubber. Raised Face Mating Flange: Flat ring 1/8-inch ethylene propylene (EPR) rubber, with filler gasket between OD of raised face and flange OD to protect the flange from bolting moment.

SECTION 40 27 00.11 CHLORINATED POLYVINYL CHLORIDE (CPVC) PIPE AND FITTINGS		
Item	Size	Description
Solvent Cement	All	All socket type joints shall be made employing primer and solvent cements that meet or exceed the requirements of ASTM F493 and primers that meet or exceed the requirements of ASTM F656, resistant to the fluid service, and as recommended by the pipe and fitting manufacturer, except solvent weld cement for CPVC pipe joints in sodium hypochlorite service shall be free of silica filler and shall be certified by the manufacturer to be suitable for that service, IPS Weld-On 724 or approved equal. Certification shall be submitted. Solvent cement and primer shall be listed by NSF 61 for contact with potable water.
Thread Lubricant	All	Teflon tape.

END OF SECTION

SECTION 40 27 01
PROCESS PIPING SPECIALTIES

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American Society of Mechanical Engineers (ASME):
 - a. B16.1, Gray Iron Pipe Flanges and Flanged Fittings (Classes 25, 125, and 250).
 - b. B16.5, Pipe Flanges and Flanged Fittings: NPS 1/2 through NPS 24 Metric/Inch Standard.
2. American Water Works Association (AWWA):
 - a. C110/A21.10, Ductile-Iron and Gray-Iron Fittings.
 - b. C153/A21.53, Ductile-Iron Compact Fittings for Water Service.
 - c. C210, Liquid-Epoxy Coating Systems for the Interior and Exterior of Steel Water Pipelines.
 - d. C213, Fusion-Bonded Epoxy Coating for the Interior and Exterior of Steel Water Pipelines.
 - e. C219, Bolted, Sleeve-Type Couplings for Plain-End Pipe.
 - f. Manual M11, Steel Pipe—A Guide for Design and Installation.
3. ASTM International (ASTM):
 - a. A153/A153M, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
 - b. A276, Standard Specification for Stainless Steel Bars and Shapes.
4. National Fire Protection Association (NFPA): 24, Standard for the Installation of Private Fire Service Mains and Their Appurtenances.
5. NSF International (NSF):
 - a. NSF/ANSI 61, Drinking Water System Components - Health Effects.
 - b. NSF/ANSI 372, Drinking Water System Components - Lead Content.

1.02 SUBMITTALS

A. Action Submittals:

1. Manufacturer's data on materials, construction, end connections, ratings, overall lengths, and live lengths (as applicable).
2. Metal Bellows Field Finishing:
 - a. Manufacturer's recommended weld procedures for joining welded carbon steel piping to stainless steel bellows.
 - b. Welder qualifications for joining welded carbon steel piping to stainless steel bellows.

- c. Product data for field-applied System No. 4, high temperature, epoxy lining and coating in accordance with Section 09 90 00, Painting and Coating.
- B. Informational Submittals:
 - 1. Coupling Harness:
 - a. Details, ratings, calculations and test reports for thrust restraints relying on welded bars or rings.
 - b. Weld procedure qualifications.
 - c. Load proof-testing report of prototype restraint for any size coupling.
- C. Operation and Maintenance Data as specified in Section 01 78 23, Operation and Maintenance Data.

PART 2 PRODUCTS

2.01 GENERAL

- A. Provide required piping specialty items, whether shown or not shown on Drawings, as required by applicable codes and standard industry practice.
- B. Rubber ring joints, mechanical joints, flexible couplings, and proprietary restrained ductile iron pipe joints are considered flexible joints; welded, screwed, and flanged pipe joints are not considered flexible.
- C. Components and Materials in Contact with Water for Human Consumption: Comply with the requirements of the Safe Drinking Water Act and other applicable federal, state, and local requirements. Provide certification by manufacturer or an accredited certification organization recognized by the Authority Having Jurisdiction that components and materials comply with the maximum lead content standard in accordance with NSF/ANSI 61 and NSF/ANSI 372.
 - 1. Use or reuse of components and materials without a traceable certification is prohibited.

2.02 CONNECTORS

- A. Teflon Bellows Connector:
 - 1. Type: Two convolutions, unless otherwise shown, with metal reinforcing bands.
 - 2. Flanges: Ductile iron, drilled 150 psi ASME B16.5 standard.
 - 3. Working Pressure Rating: 140 psi, minimum, at 120 degrees F.

4. Thrust Restraint: Limit bolts to restrain force developed by specified test pressure.
5. Manufacturers and Products:
 - a. Garlock; Style 214.
 - b. Resistoflex; No. R6904.
 - c. Unisource Manufacturing, Inc.; Style 112.
 - d. Proco Products, Inc.; Series 442.

B. Quick Connect Couplings for Chemical Services:

1. Type: Twin cam arm actuated, male and female, locking, for chemical loading and transfer.
2. Materials: Glass-filled polypropylene or PVDF with EPDM, Viton-A or Teflon gaskets as recommended for the service by manufacturer.
3. End Connections: NPT threaded or flanged to match piping connections. Hose shank for chemical installations.
4. Plugs and Caps: Female dust cap for each male end; male dust plug for each female end.
5. Pressure Rating: 125 psi, minimum, at 70 degrees F.
6. Manufacturers and Products:
 - a. OPW; Kamlock.
 - b. Ryan Herco; 1300 Series.

2.03 PIPE SLEEVES

A. Steel Pipe Sleeve:

1. Minimum Thickness: 3/16 inch.
2. Seep Ring:
 - a. Center steel flange for water stoppage on sleeves in exterior or water-bearing walls, 3/16-inch minimum thickness.
 - b. Outside Diameter: Unless otherwise shown, 3 inches greater than pipe sleeve outside diameter.
 - c. Continuously fillet weld on each side all around.
3. Factory Finish:
 - a. Galvanizing:
 - 1) Hot-dip applied, meeting requirements of ASTM A153/A153M.
 - 2) Electroplated zinc or cadmium plating is unacceptable.
 - b. Shop Lining and Coating: Factory prepare, prime, and finish coat in accordance with Section 09 90 00, Painting and Coating.

B. Molded Polyethylene Pipe Sleeve:

1. Molded HDPE with integral water stop ring not less than 3 inches larger than sleeve.

2. Provided with end caps for support during concrete placement.
3. Manufacturer and Product: Century-Line, Model CS sleeves as manufactured by PSI-Thunderline/Link-Seal.

C. Insulated and Encased Pipe Sleeve:

1. Manufacturer and Product: Pipe Shields, Inc.; Models WFB, WFB-CS and -CW Series, as applicable.

D. Modular Mechanical Seal:

1. Type: Interconnected synthetic rubber links shaped and sized to continuously fill annular space between pipe and wall sleeve opening.
2. Fabrication:
 - a. Assemble interconnected rubber links with ASTM A276, Type 316 stainless steel bolts and nuts.
 - b. Pressure plates shall be reinforced nylon polymer.
3. Size: According to manufacturer's instructions for size of pipes shown to provide a watertight seal between pipe and wall sleeve opening, and to withstand a hydrostatic head of 40 feet of water.
4. Manufacturer: Thunderline Corp., Link-Seal Division.

2.04 CHEMICAL INJECTOR SYSTEM

A. Chemical Injectors:

1. Type, size, quantity, and materials as shown on Drawings and Standard Details.
2. Manufacturer: SAF-T-FLO.

B. Support System:

1. Stainless steel Unistrut or FRP Aickenstrut.
2. Materials compatible with chemical service and subject to Engineer approval.

C. Connectors: Stainless steel service saddle or weld-o-let, as shown on Drawings.

2.05 MISCELLANEOUS SPECIALTIES

A. Strainers, Water Service, 2 Inches and Smaller:

1. Type: Bronze body, Y-pattern, 200 psi nonshock rated, with screwed gasketed bronze cap.
2. Screen: Heavy-gauge Type 304 stainless steel or monel, 20-mesh.

3. Manufacturers and Products:
 - a. Armstrong International; Inc.; Model F.
 - b. Mueller Steam Specialty; Model 351M.
- B. Strainers, Water Service, 2-1/2 Inches and Larger:
1. Type: Cast iron or ductile iron body, Y-pattern, 175 psi nonshock rated, with flanged gasketed iron cap.
 2. Screen: Heavy-gauge Type 316 stainless steel, 0.045-inch perforations.
 3. Manufacturer and Product: Armstrong International, Inc.; Model A7FL 125.
- C. Strainers, Plastic Piping Systems, 4 Inches and Smaller:
1. Type: Y-pattern PVC body, 150 psi nonshock rated, with screwed PVC cap and Viton seals.
 2. End Connections: Screwed or solvent weld, 2 inches and smaller. Class 150 ANSI flanged, 2-1/2 inches and larger.
 3. Screen: Heavy-gauge PVC, 1/32-inch mesh, minimum 2 to 1 screen area to pipe size ratio.
 4. Manufacturer: Hayward.
- D. Water Hose:
1. Furnish one hose per new hose rack in all locations. Hose shall match the hose bib or hydrant size.
 2. 3/4-Inch and 1-inch Hose: 50-foot length rubber hose. EPDM black cover and EPDM tube, reinforced with two textile braids. Provide each length with brass male and female NST hose thread couplings to fit hose nozzle and hose valve.
 3. Rated minimum working pressure of 200 psi.
 4. Manufacturers:
 - a. Goodyear.
 - b. Boston.
- E. Hose Nozzles:
1. Furnish one hose nozzle per water hose. Nozzle shall match the hose size. Cast brass, satin finish, nozzles with adjustable fog, straight-stream, and shut-off feature and rubber bumper. Provide nozzles with female NST hose thread.
 2. Manufacturers:
 - a. Croker.
 - b. Elkhart.

PART 3 EXECUTION

3.01 GENERAL

- A. Provide accessibility to piping specialties for control and maintenance.

3.02 PIPING TRANSITION

A. Applications:

1. Provide complete closure assembly where pipes meet other pipes or structures.
2. Pressure Pipeline Closures: Plain end pieces with double flexible couplings, unless otherwise shown.
3. Restrained Joint Pipe Closures: Install with thrust tie-rod assemblies as shown or in accordance with NFPA 24.
4. Gravity Pipe Closures: As specified for pressure pipelines, or concrete closures.
5. Concrete Closures: Use to make connections between dissimilar pipe where standard rubber gasketed joints or flexible couplings are impractical, as approved.
6. Elastomer sleeves bonded to pipe ends are not acceptable.

B. Installation:

1. Flexible Transition Couplings: Install in accordance with coupling manufacturer's instructions to connect dissimilar pipe and pipes with a small difference in outside diameter.
2. Concrete Closures:
 - a. Locate away from structures so there are at least two flexible joints between closure and pipe entering structure.
 - b. Clean pipe surface before placing closure collars.
 - c. Wet nonmetallic pipe thoroughly prior to pouring collars.
 - d. Prevent concrete from entering pipe.
 - e. Extend collar a minimum of 12 inches on each side of joint with minimum thickness of 6 inches around outside diameter of pipe.
 - f. Make entire collar in one placement.
 - g. After concrete has reached initial set, cure by covering with well-moistened earth.

3.03 FLEXIBLE PIPE CONNECTIONS TO EQUIPMENT

- A. Install to prevent piping from being supported by equipment, for vibration isolation, and where shown.

B. Product Applications Unless Shown Otherwise:

1. Nonmetallic Piping: Teflon bellows connector.
2. Copper Piping: Flexible metal hose connector.
3. Compressor and Blower Discharge: Metal bellows connector.
4. All Other Piping: Elastomer bellows connector.

C. Limit Bolts and Control Rods: Tighten snug prior to applying pressure to system.

3.04 PIPE SLEEVES

A. Application:

1. As specified in Section 40 27 00, Piping—General.
2. Above Grade in Nonsubmerged Areas: Hot-dip galvanized after fabrication.
3. Below Grade or in Submerged or Damp Environments: Shop-lined and coated.
4. Alternatively, Molded Polyethylene Pipe Sleeve as specified may be applied.

B. Installation:

1. Support noninsulating type securely in formwork to prevent contact with reinforcing steel and tie-wires.
2. Caulk joint with specified sealant in non-submerged applications and seal below grade and submerged applications with wall penetration seal.

3.05 CHEMICAL INJECTOR SYSTEM

A. Install in accordance with manufacturer's instructions.

END OF SECTION

SECTION 40 27 02 PROCESS VALVES AND OPERATORS

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American Gas Association (AGA): 3, Orifice Metering of Natural Gas and Other Related Hydrocarbon Fluids.
2. American National Standards Institute (ANSI): Z21.15, Manually Operated Gas Valves for Appliances, Appliance Connector Valves and Hose End Valves.
3. American Society of Mechanical Engineers (ASME):
 - a. B16.1, Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250.
 - b. B16.44, Manually Operated Metallic Gas Valves for Use in Above Ground Piping Systems up to 5 psi.
4. American Society of Sanitary Engineers (ASSE): 1011, Performance Requirements for Hose Connection Vacuum Breakers.
5. American Water Works Association (AWWA):
 - a. C111/A21.11, Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
 - b. C500, Metal-Seated Gate Valves for Water Supply Service.
 - c. C504, Rubber-Seated Butterfly Valves, 3 In. (75 mm) Through 72 In. (1,800 mm).
 - d. C508, Swing-Check Valves for Waterworks Service, 2-In. Through 24-In. (50-mm Through 600-mm) NPS.
 - e. C509, Resilient-Seated Gate Valves for Water Supply Service.
 - f. C510, Double Check Valve Backflow Prevention Assembly.
 - g. C511, Reduced-Pressure Principle Backflow Prevention Assembly.
 - h. C512, Air-Release, Air/Vacuum, and Combination Air Valves for Waterworks Service.
 - i. C515, Reduced-Wall, Resilient-Seated Gate Valves for Water Supply Service.
 - j. C541, Hydraulic and Pneumatic Cylinder and Vane-Type Actuators for Valves and Slide Gates.
 - k. C542, Electric Motor Actuators for Valves and Slide Gates.
 - l. C550, Protective Interior Coatings for Valves and Hydrants.
 - m. C606, Grooved and Shouldered Joints.
 - n. C800, Underground Service Line Valves and Fittings.

6. ASTM International (ASTM):
 - a. A276, Standard Specification for Stainless Steel Bars and Shapes.
 - b. A351/A351M, Standard Specification for Castings, Austenitic, for Pressure-Containing Parts.
 - c. A380, Standard Practice for Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment, and Systems.
 - d. A564/A564M, Standard Specification for Hot-Rolled and Cold-Finished Age-Hardening Stainless Steel Bars and Shapes.
 - e. B61, Standard Specification for Steam or Valve Bronze Castings.
 - f. B62, Standard Specification for Composition Bronze or Ounce Metal Castings.
 - g. B98/B98M, Standard Specification for Copper-Silicon Alloy Rod, Bar, and Shapes.
 - h. B127, Standard Specification for Nickel-Copper Alloy (UNS N04400) Plate, Sheet, and Strip.
 - i. B139/B139, Standard Specification for Phosphor Bronze Rod, Bar and Shapes.
 - j. B164, Standard Specification for Nickel-Copper Alloy Rod, Bar, and Wire.
 - k. B194, Standard Specification for Copper-Beryllium Alloy Plate, Sheet, Strip, and Rolled Bar.
 - l. B584, Standard Specification for Copper Alloy Sand Castings for General Applications.
 - m. D429, Standard Test Methods for Rubber Property-Adhesion to Rigid Substrates.
 - n. D1784, Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds.
7. Canadian Standards Association, Inc. (CSA): 9.1, Manually Operated Gas Valves for Appliances, Appliance Connector Valves and Hose End Valves.
8. Chlorine Institute (CI): Pamphlet 6, Piping Systems for Dry Chlorine.
9. FM Global (FM).
10. Food and Drug Administration (FDA).
11. International Association of Plumbing and Mechanical Officials (IAPMO).
12. Manufacturers Standardization Society (MSS):
 - a. SP-80, Bronze Gate, Globe, Angle, and Check Valves.
 - b. SP-81, Stainless Steel, Bonnetless, Flanged Knife Gate Valves.
 - c. SP-85, Gray Iron Globe and Angle Valves, Flanged and Threaded Ends.
 - d. SP-88, Diaphragm Valves.
 - e. SP-110, Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends.

13. National Electrical Manufacturers Association (NEMA): 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
14. NSF International (NSF):
 - a. NSF/ANSI 61, Drinking Water System Components - Health Effects.
 - b. NSF/ANSI 372, Drinking Water System Components - Lead Content.
15. Underwriters Laboratories (UL).
16. USC Foundation for Cross-Connection Control and Hydraulic Research.

1.02 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
 - a. Product data sheets for each make and model. Indicate valve Type Number, applicable Tag Number, and facility name/number or service where used.
 - b. Complete catalog information, descriptive literature, specifications, and identification of materials of construction.
 - c. Certification for compliance to NSF/ANSI 61 for valves used for drinking water service.
 - d. Sizing calculations for open-close/throttle and modulating valves.

B. Informational Submittals:

1. Manufacturer's Certificate of Compliance, in accordance with Section 01 61 00, Common Product Requirements, for:
 - a. Electric actuators; full compliance with AWWA C542.
 - b. Butterfly valves; full compliance with AWWA C504.
2. Component and attachment testing seismic certificate of compliance as required by Section 01 45 33, Special Inspection, Observation, and Testing.
3. Tests and inspection data.
4. Operation and Maintenance Data as specified in Section 01 78 23, Operation and Maintenance Data.
5. Manufacturer's Certificate of Proper Installation, in accordance with Section 01 43 33, Manufacturers' Field Services.

PART 2 PRODUCTS

2.01 GENERAL

- A. Valves to include operator, actuator, handwheel, chain wheel, extension stem, floor stand, operating nut, chain, wrench, and accessories to allow a complete operation from the intended operating level.

- B. Valve to be suitable for intended service. Renewable parts not to be of a lower quality than specified.
- C. Valve same size as adjoining pipe, unless otherwise called out on Drawings or in Supplements.
- D. Valve ends to suit adjacent piping.
- E. Resilient seated valves shall have no leakage (drip-tight) in either direction at valve rated design pressure. All other valves shall have no leakage (drip-tight) in either direction at valve rated design pressure, unless otherwise allowed for in this section or in stated valve standard.
- F. Size operators and actuators to operate valve for full range of pressures and velocities.
- G. Valve to open by turning counterclockwise, unless otherwise specified.
- H. Factory mount operator, actuator, and accessories.
- I. Components and Materials in Contact with Water for Human Consumption: Comply with the requirements of the Safe Drinking Water Act and other applicable federal, state, and local requirements. Provide certification by manufacturer or an accredited certification organization recognized by the Authority Having Jurisdiction that components and materials comply with the maximum lead content standard in accordance with NSF/ANSI 61 and NSF/ANSI 372. Use or reuse of components and materials without a traceable certification is prohibited.

2.02 SCHEDULE

- A. Additional requirements relative to this section are shown on Self-Regulated Valve Schedule located at the end of this section.

2.03 MATERIALS

- A. Bronze and brass valve components and accessories that have surfaces in contact with water to be alloys containing less than 16 percent zinc and 2 percent aluminum.
 - 1. Approved alloys are of the following ASTM designations: B61, B62, B98/B98M (Alloy UNS No. C65100, C65500, or C66100), B139/B139M (Alloy UNS No. C51000), B584 (Alloy UNS No. C90300 or C94700), B164, B194, and B127.
 - 2. Stainless steel Alloy 18-8 may be substituted for bronze.

- B. Valve materials in contact with or intended for drinking water service to meet the following requirements:
 - 1. Materials to comply with requirements of the Safe Drinking Water Act and other applicable federal, state, and local requirements.
 - 2. Coatings materials to be formulated from materials deemed acceptable to NSF/ANSI 61.
 - 3. Supply certification product is certified as suitable for contact with drinking water by an accredited certification organization in accordance with NSF/ANSI 61. Provide certification for each valve type used for drinking water service.

2.04 FACTORY FINISHING

- A. General:
 - 1. Interior coatings for valves and hydrants shall be in accordance with AWWA C550, unless otherwise specified.
 - 2. Exterior coating for valves and hydrants shall be in accordance with Section 09 90 00, Painting and Coating.
 - 3. Material in contact with potable water shall conform to NSF/ANSI 61.
 - 4. Exposed safety isolation valves and lockout valves with handles, handwheels, or chain wheels shall be "safety yellow."
- B. Where epoxy lining and coating are specified, factory finishing shall be as follows:
 - 1. In accordance with AWWA C550.
 - 2. Either two-part liquid material or heat-activated (fusion) material except only heat-activated material if specified as "fusion" or "fusion bonded" epoxy.
 - 3. Minimum 7-mil dry film thickness except where limited by valve operating tolerances.

2.05 VALVES

- A. Globe valve:
 - 1. Type V235 Angle Type Hose Valve 3/4 Inch:
 - a. 3/4-inch NPT female inlet, 3/4-inch male hose thread outlet, heavy rough brass body rated 125 psi, lockshield bonnet, removable handle, atmospheric vacuum breaker conforming to ASSE 1011 and IAPMO code.
 - b. Manufacturers and Products:
 - 1) Acorn; 8126, surface pipe mount valve, bent nose without flange.

- 2) Acorn; 8121, surface mount through wall valve, bent nose with flange.
- 3) Acorn; 8131, pipe and pedestal mounted valve located above 6 inches, straightnose.
- 4) Acorn; 8136, pedestal mounted valve located lower than 6 inches, inverted nose.

B. Ball Valves:

1. Type V300 Ball Valve 3 Inches and Smaller for General Water and Air Service:
 - a. Two-piece, standard port, NPT threaded ends, bronze body and end piece, hard chrome-plated solid bronze or brass ball, RTFE seats and packing, blowout-proof stem, adjustable packing gland, zinc-coated steel hand lever operator with vinyl grip, rated 600-pound WOG, 150-pound SWP, complies with MSS SP-110. For steam service, provide stainless steel ball and stem.
 - b. Manufacturers and Products:
 - 1) Threaded:
 - a) Conbraco Apollo; 70-100.
 - b) Nibco; T-580-70.
 - 2) Soldered:
 - a) Conbraco Apollo; 70-200.
 - b) Nibco; S-580-70.
2. Type V307 Stainless Steel Ball Valve 2 Inches and Smaller:
 - a. Three-piece, full port, ASTM A276 GR 316 or ASTM A351/A351M GR CF8M stainless steel body and end pieces, Type 316 stainless steel ball, NPT threaded ends, reinforced PTFE seats, seals, and packing, adjustable packing gland, blowout-proof stainless steel stem, stainless steel lever operator with vinyl grip, rated 800 psig to 1,000 psig CWP, complies with MSS SP-110.
 - b. Manufacturers and Products:
 - 1) Conbraco Apollo; 86R-100/86-500 Series.
 - 2) Nibco; T-595-S6-R-66-LL.
3. Type V330 PVC Ball Valve 2 Inches and Smaller:
 - a. Rated 150 psi at 73 degrees F, with ASTM D1784, Type I, Grade 1 polyvinyl chloride body, ball, and stem, end entry, double union design, solvent-weld socket ends, elastomer seat, Viton or Teflon O-ring stem seals, to block flow in both directions. Provide pressure relief hole drilled on low pressure side of ball.
 - b. Manufacturers and Products:
 - 1) Nibco; Chemtrol Tru-Bloc.
 - 2) ASAHI/America; Type 21.
 - 3) Spears; True Union.

4. Type V335 CPVC Ball Valve 2 Inches and Smaller:
 - a. Rated 150 psi at 100 degrees F, 80 psi at 140 degrees, with ASTM D1784, Type IV, Grade 1 chlorinated polyvinyl chloride (CPVC) body, ball, and stem, end entry, double union design, with solvent-weld socket ends or single union ball with flanged ends drilled to ASME B16.1, replaceable Teflon seat, Viton or Teflon O-ring stem seals, to block flow in both directions. Provide pressure relief hole drilled on low pressure side of ball.
 - b. Manufacturers and Products:
 - 1) Nibco; Chemtrol Tru-Bloc.
 - 2) ASAHI/America; Type 21.
 - 3) Spears; True Union.

C. Check and Flap Valves:

1. Type V630 PVC Ball Check Valve 4 Inches and Smaller:
 - a. ASTM D1784, Type I, Grade 1 polyvinyl chloride body, dual union socket weld ends, rated 150 psi at 73 degrees F, and Viton seat and seal.
 - b. Manufacturers and Products:
 - 1) Nibco; Chemtrol Tru Union.
 - 2) ASAHI/America.
 - 3) Spears; True Union.
2. Type V642 Reduced-Pressure Principle Backflow Prevention Assembly 3/4 Inch to 10 Inches:
 - a. Two resilient seated check valves with an independent relief valve between the valves, two nonrising stem outside screw and yoke resilient-seated isolation valves, test cocks, in accordance with AWWA C511, rated 175 psi maximum working pressure, meets requirements of USC Foundation For Cross-Connection Control and Hydraulic Research.
 - b. Manufacturers and Products:
 - 1) FEBCO; Model 860.
 - 2) Danfoss Flomatic; Model RPZE/RPZ.
 - 3) Watts; Series 009/909.

D. Self-Regulated Automatic Valves:

1. Type V710 Pressure-Reducing Valve 2-1/2 Inches and Smaller:
 - a. Direct diaphragm operated, spring controlled, bronze body, NPT threaded ends, 200-psig rated minimum.
 - b. Size/Rating: As shown in Valve Schedule.
 - c. Manufacturers and Products:
 - 1) Fisher; Type 75A.
 - 2) Watts; Series 223.

2. Type V725 Automatic Degassing Valve, 1/2 Inch to 3/4 Inch:
 - a. PVC or CPVC construction with Viton seals, NPT threaded inlet and outlet, float designed to automatically vent gases, 150 psi design pressure.
 - b. Manufacturers and Products:
 - 1) O-Matic; Series DGV.
 - 2) Primary Fluid Systems, Inc.; Accu-Vent.
3. Type V730 Pressure-Relief Valve 2 Inches and Smaller:
 - a. Direct diaphragm, spring controlled, cast-iron body, spring case, nitrileseat neoprene diaphragm, stainless steel valve stem, NPT threaded ends, 200 psi rated.
 - b. Opens when upstream pressure reaches a maximum set point.
 - c. Size/Rating: As shown in Valve Schedule.
 - d. Manufacturer and Product: Fisher; 98 Series.

E. Miscellaneous Valves:

1. Type V903 Diaphragm Valve, 1/2 Inch to 4 Inches:
 - a. Weir type with CPVC Type 4, Grade 1 body, PTFE with EPDM backing and with PVDF gas barrier diaphragm, double union design, solvent weld socket ends flanged ends, handwheel operator, position indicator, adjustable travel stop, clear molded acrylic stem cap.
 - b. Manufacturers and Products:
 - 1) ASAHI/AMERICA; Diaphragm Valve Type 14.
 - 2) ITT Engineered Valves; Dia-Flo.
 - 3) Saunders Valve; Diaphragm Valve.

2.06 OPERATORS AND ACTUATORS

A. Manual Operators:

1. General:
 - a. For AWWA valves, operator force not to exceed requirements of applicable valve standard. Provide gear reduction operator when force exceeds requirements.
 - b. For non-AWWA valves, operator force not to exceed applicable industry standard or 80 pounds, whichever is less, under operating condition, including initial breakaway. Provide gear reduction operator when force exceeds requirements.
 - c. Operator self-locking type or equipped with self-locking device.
 - d. Position indicator on quarter-turn valves.
 - e. Worm and gear operators one-piece design, worm-gears of gear bronze material. Worm of hardened alloy steel with thread ground and polished. Traveling nut type operator's threaded steel reach rod with internally threaded bronze or ductile iron nut.

2. Exposed Operator:
 - a. Galvanized and painted handwheel.
 - b. Cranks on gear type operator.
 - c. Chain wheel operator with tieback, extension stem, floor stand, and other accessories to permit operation from normal operation level.
 - d. Valve handles to take a padlock, and wheels a chain and padlock.
3. Buried Operator:
 - a. Buried service operators on valves larger than 2-1/2 inches shall have a 2-inch AWWA operating nut. Buried operators on valves 2 inches and smaller shall have cross handle for operation by forked key. Enclose moving parts of valve and operator in housing to prevent contact with the soil.
 - b. Buried service operators to be grease packed and gasketed to withstand submersion in water to 20 feet minimum.
 - c. Buried valves shall have extension stems, bonnets, and valve boxes.

2.07 ACCESSORIES

- A. Tagging: 1-1/2-inch diameter heavy brass or stainless steel tag attached with No. 16 solid brass or stainless steel jack chain for each valve, bearing valve tag number shown on Self-Regulated Valve Schedule.
- B. Cast-Iron Valve Box: Designed for traffic loads, sliding type, with minimum of 5-1/4-inch ID shaft.
 1. Box: Cast iron with minimum depth of 9 inches.
 2. Lid: Cast iron, minimum depth 3 inches, nonlocking type marked WATER, SEWER, GAS.
 3. Extensions: Cast iron.
 4. Two-piece box and lid for valves 4 inches through 12 inches, three-piece box and lid for valves larger than 12 inches with base sized for valve.
 5. Valve extension stem for valves with operating nuts 3 feet or greater below finish grade.
 6. Manufacturers and Products:
 - a. East Jordan Iron Works; Cast-Iron Valve Boxes.
 - b. Bingham & Taylor; Cast-Iron Valve Boxes.
- C. Indicator Post Assembly:
 1. Cast or ductile iron post head, bell, and wrench with cast or ductile iron or steel barrel.
 2. Plexiglas or equal protected window to indicate OPEN and CLOSED position.
 3. Padlockable eye bolt for wrench.

4. Adjustable bury depth. Bury depth as required for valve installation.
5. UL Listed and FM Approved.
6. Manufacturers and Products:
 - a. Clow; Style 2945.
 - b. Mueller; A-20806.

PART 3 EXECUTION

3.01 INSTALLATION

A. Flange Ends:

1. Flanged valve bolt holes shall straddle vertical centerline of pipe.
2. Clean flanged faces, insert gasket and bolts, and tighten nuts progressively and uniformly.

B. Screwed Ends:

1. Clean threads by wire brushing or swabbing.
2. Apply joint compound.

C. PVC and CPVC Valves: Install using solvents approved for valve service conditions.

D. Valve Installation and Orientation:

1. General:
 - a. Install valves so handles operate from fully open to fully closed without encountering obstructions.
 - b. Install valves in location for easy access for routine operation and maintenance.
 - c. Install valves per manufacturer's recommendations.
2. Gate, Globe, and Ball Valves:
 - a. Install operating stem vertical when valve is installed in horizontal runs of pipe having centerline elevations 4 feet 6 inches or less above finished floor, unless otherwise shown.
 - b. Install operating stem horizontal in horizontal runs of pipe having centerline elevations greater than 4 feet 6 inches above finish floor, unless otherwise shown.
3. Check Valves:
 - a. Install valve in accordance with manufacturer's instructions and provide required distance from immediate upstream fitting.
 - b. Install valve in vertical flow (up) piping only for gas services.
 - c. Install swing check valve with shaft in horizontal position.
 - d. Install double disc swing check valve to be perpendicular to flow pattern when discs are open.
4. Solenoid Valves: Install in accordance with manufacturer's instructions.

- E. Install line size ball valve and union upstream of each solenoid valve, in-line flow switch, or other in-line electrical device, excluding magnetic flowmeters, for isolation during maintenance.
- F. Locate valve to provide accessibility for control and maintenance. Install access doors in finished walls and plaster ceilings for valve access.
- G. Floor Box and Stem: Steel extension stem length shall locate operating nut in floor box.

3.02 TESTS AND INSPECTION

- A. Valve may be either tested while testing pipelines, or as a separate step.
- B. Test that valves open and close smoothly under operating pressure conditions. Test that two-way valves open and close smoothly under operating pressure conditions from both directions.
- C. Inspect air and vacuum valves as pipe is being filled to verify venting and seating is fully functional.
- D. Count and record number of turns to open and close valve; account for discrepancies with manufacturer's data.
- E. Set, verify, and record set pressures for relief and regulating valves.
- F. Automatic valves to be tested in conjunction with control system testing. Set opening and closing speeds, limit switches, as required or recommended by Engineer.
- G. Test hydrostatic relief valve seating; record leakage. Adjust and retest to maximum leakage of 0.1 gpm per foot of seat periphery.

3.03 MANUFACTURER'S SERVICES

- A. Manufacturer's Representative: Present at Site for minimum person-days listed below, travel time excluded:
 - 1. 1 person-day for installation assistance and inspection.
 - 2. 1 person-day for functional and performance testing and completion of Manufacturer's Certificate of Proper Installation.
- B. See Section 01 43 33, Manufacturers' Field Services, and Section 01 91 14, Equipment Testing and Facility Startup.

3.04 SUPPLEMENTS

- A. The supplement listed below, following “End of Section,” is part of this Specification.
 - 1. Self-Regulated Valve Schedule.

END OF SECTION

Self-Regulated Valve Schedule							
Tag No.	Valve Type No.	Size (inches)	Inlet* Pressure	Outlet* Pressure	Maximum psig	Flow (gpm)	Fluid
PRV-211-3	V710	1 ½	150	110	175	8	W2
PSV-211-4	V730	1 ½	150	N/A	175	8	W2
PSV-213-3	V725	1/2	50	N/A	75	0.08	PUR
*Inlet Pressure = Set pressure for pressure relief valve or downstream set pressure for pressure reducing valve.							

SECTION 40 42 13
PROCESS PIPING INSULATION

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American Society of Heating, Refrigerating and Air Conditioning Engineers Inc. (ASHRAE): 90.1, Energy Standard for Buildings Except Low-Rise Residential Buildings.
2. ASTM International (ASTM):
 - a. B209, Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
 - b. C165, Standard Test Method for Measuring Compressive Properties of Thermal Insulations.
 - c. C177, Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus.
 - d. C518, Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.
 - e. C534/C534M, Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form.
 - f. C547, Standard Specification for Mineral Fiber Pipe Insulation.
 - g. C552, Standard Specification for Cellular Glass Thermal Insulation.
 - h. C585, Standard Practice for Inner and Outer Diameters of Thermal Insulation for Nominal Sizes of Pipe and Tubing.
 - i. C1136, Standard Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation.
 - j. C1729, Standard Specification for Aluminum Jacketing for Insulation.
 - k. E84, Standard Test Method for Surface Burning Characteristics of Building Materials.
 - l. E96/E96M, Standard Test Methods for Water Vapor Transmission of Materials.
3. International Code Council (ICC): International Energy Conservation Code (IECC).
4. Underwriters Laboratories Inc. (UL).

1.02 SUBMITTALS

- A. Action Submittals: Manufacturer's descriptive literature.
- B. Informational Submittals: Maintenance information.

PART 2 PRODUCTS

2.01 PIPE AND FITTING INSULATION

- A. Type 1—Elastomeric:
 - 1. Material: Flexible elastomeric pipe insulation, closed-cell structure in accordance with ASTM C534/C534M.
 - 2. Temperature Rating: Minus 297 degrees F to 220 degrees F.
 - 3. Nominal Density: 3 pcf to 6 pcf.
 - 4. Conductivity in accordance with ASHRAE 90.1 and maximum numerical value of 0.25 Btu-in./hr-square foot degrees F at 75 degrees F per ASTM C177 or ASTM C518.
 - 5. Maximum water vapor transmission of 0.06 perm-inch per ASTM E96/E96M, Procedure A.
 - 6. Joints: Manufacturer's adhesive.
 - 7. Flame Spread Rating: Less than 25 per ASTM E84.
 - 8. Smoke Developed Index: Less than 50 per ASTM E84.
 - 9. Manufacturers and Products:
 - a. Nomaco; K-Flex.
 - b. Armacell; AP Armaflex.
- B. Type 2—Fiberglass:
 - 1. Material: UL rated, preformed, sectional bonded fiberglass per ASTM C585 with factory applied, Kraft paper with aluminum foil vapor barrier jacket with pressure-sensitive, self-sealing lap.
 - 2. Insulation Temperature Rating: Zero to 850 degrees F.
 - 3. Conductivity in accordance with ASHRAE 90.1 and maximum numerical value of 0.23 Btu-in./hr-square foot degrees F at 75 degrees F.
 - 4. Jacketing per ASTM C1136 with minimum water vapor transmission for jacket of 0.02 perm-inch per ASTM E96/E96M. Furnish with no jacket if field finish system specified.
 - 5. Joints: Matching pressure-sensitive butt strips for sealing circumferential joints.
 - 6. Flame Spread Rating: Less than 25 per ASTM E84.
 - 7. Smoke Developed Index: Less than 50 per ASTM E84.
 - 8. Manufacturers and Products:
 - a. Owens Corning Fiberglass; ASJ/SSL-11.
 - b. John Manville; Micro-Lok with Jacket.

C. Type 3—Foamglass:

1. Material: Cellular glass per ASTM C552.
2. Nominal Density: 7.5 pcf.
3. Compressive Strength: 90 psi per ASTM C165.
4. Temperature Rating: Minus 290 degrees F to 900 degrees F.
5. Conductivity in accordance with ASHRAE 90.1 and maximum numerical value of 0.29 Btu-in./hr-square foot degrees F.
6. Minimum water vapor transmission for insulation of 0.00 perm-inch per ASTM E96/E96M.
7. Joints: Matching pressure-sensitive butt strips for sealing circumferential joints.
8. Flame Spread Rating: 0 per ASTM E84.
9. Smoke Developed Index: 0 per ASTM E84.
10. Follow manufacturer's recommendation, based upon temperature of piping to be insulated.
11. Manufacturer and Product: Pittsburgh Corning; Foamglas One.

2.02 INSULATION AT PIPE HANGERS AND SUPPORTS

- A. Refer to Section 40 05 15, Piping Support Systems.
- B. Copper, Ductile Iron, and Nonmetallic Pipe: High-density insert, thickness equal to adjoining insulation of Type 3 or other rigid insulation or manufactured pre-insulated pipe hanger and insulation shield. Extend insert beyond shield.
- C. Steel Pipe: Insulation saddle or high-density insert, thickness equal to adjoining insulation of Type 3 or other rigid insulation or manufactured pre-insulated pipe hanger and insulation shield at support location. Extend insert beyond shield.

2.03 INSULATION FINISH SYSTEMS

A. Type F1—PVC:

1. Polyvinyl chloride (PVC) jacketing, minimum 20 mils indoors and 30 mils outdoors, for straight run piping and fitting locations, temperatures to 140 degrees F.
2. Color: PVC jacketing shall be color coded to match colors listed in pipe schedule where suitable matching colors are available. If no suitable colors are available jacketing shall be white.
3. Flame Spread Rating: 25 per ASTM E84.
4. Smoke Developed Index: 50 per ASTM E84.
5. Manufacturers and Products:
 - a. Knauf Insulation; Proto 1000.
 - b. Johns Manville; Zeston 2000 or 300.
 - c. Speedline; 25/50 Smoke-Safe.

B. Type F2—Paint:

1. Type 1 Insulation: Acrylic latex paint, white, and suitable for outdoor use.
 - a. Manufacturer and Product: Armacell; WB Armaflex finish.
2. Type 2 Insulation: In accordance with Section 09 90 00, Painting and Coating.

C. Type F3—Aluminum:

1. Aluminum Roll Jacketing: For straight run piping, wrought aluminum Alloy 3003, 5005, 1100, or 3105 to ASTM B209 with H-14 temper, in accordance with ASTM C1729, minimum 0.016-inch thickness, with smooth mill finish.
2. Vapor Barrier: Provide factory applied vapor barrier, heat and pressure bonded to inner surface of aluminum jacketing.
3. Fitting Covers: Material as for aluminum roll jacketing, premolded, one or two piece covers, which includes elbows, tee/valves, end caps, mechanical line couplings, and specialty fittings.
4. Manufacturers:
 - a. RPR Products; Insul-Mate.
 - b. ITW, Pabco-Childers.

D. Type F4—Foamglass Jacketing:

1. Type 3 Insulation—Buried and Up to 1 Foot Above Grade: 70-mil bituminous resin with woven, glass fabric, aluminum foil layer, and plastic film coating, self-sealing manual pressure seals; Pittsburgh Corning Pittwrap SS.
2. Type 3 Insulation—Greater than 1 Foot Above Grade: 30-mil modified bituminous membrane with self-sealing manual pressure seals; Pittsburgh Corning Pittwrap CW30.

PART 3 EXECUTION

3.01 APPLICATION

A. General:

1. Insulate valve bodies, flanges, and pipe couplings.
2. Insulate and vapor seal hangers, supports, anchors, and other piping appurtenances that are secured directly to cold surfaces.
3. Do not insulate flexible pipe couplings and expansion joints.
4. Service and Insulation Thickness: Refer to Supplement Service and Insulation Thickness table following “End of Section” and to Piping Schedule in Section 40 27 00, Piping—General.

3.02 INSTALLATION

A. General:

1. Install in accordance with manufacturer's instructions and as specified herein.
2. Install after piping system has been pressure tested and leaks corrected.
3. Install over clean dry surfaces.
4. Use insulating cements, lagging adhesives, and weatherproof mastics recommended by insulation manufacturer.
5. Do not allow insulation to cover nameplates or code inspection stamps.
6. Run insulation or insulation inserts continuously through pipe hangers and supports, wall openings, ceiling openings, and pipe sleeves, unless otherwise shown.
7. Install removable insulation sections on devices that require access for maintenance of equipment or removal, such as unions and strainer end plates.
8. Personnel Protection: Install on pipes from floor to 8 feet high. Install on pipes within 4 feet of platforms and to 8 feet high above platforms.

B. Connection to Existing Piping: Cut back existing insulation to remove portion damaged by piping revisions. Install new insulation.

C. Cold Surfaces: Provide continuous vapor seal on insulation on cold surfaces where vapor barrier jackets are used.

D. Placement:

1. Insulate valves and fittings with sleeved or cut pieces of same material.
2. Seal and tape joints.

E. Heat Traced Piping: Apply insulation after heat-tracing work is completed and inspected.

F. Vapor Barrier:

1. Provide continuous vapor barrier at joints between rigid insulation and pipe insulation.
2. Install vapor barrier jackets with pipe hangers and supports outside jacket.
3. Do not use staples and screws to secure vapor sealed system components.

G. Aluminum Jacket:

1. Use continuous friction type joint to hold jacket in place, providing positive weatherproof seal over entire length of jacket.
2. Secure circumferential joints with preformed snap straps containing weatherproof sealant.
3. On exterior piping, apply coating over insulation and vapor barrier to prevent damage when aluminum fitting covers are installed.
4. Do not use screws or rivets to fasten fitting covers.
5. Install removable prefabricated aluminum covers on exterior flanges and unions.
6. Caulk and seal exterior joints to make watertight.

3.03 FIELD FINISHING

- A. Apply coating of insulating cement where needed to obtain smooth and continuous appearance.
- B. Where pipe labels or banding are specified, apply to finished insulation, not to pipe.
- C. Painting Piping Insulation (Exposed to View):
 1. Aluminum or color coded PVC jacketing does not require painting.
 2. If insulated piping system is indicated to be painted in Section 40 27 00, Piping—General, piping shall receive the following:
 - a. Prime coat in accordance with Section 09 90 00, Painting and Coating.
 - b. Finished insulation (and not pipe) shall be painted in accordance with Section 09 90 00, Painting and Coating.

3.04 SUPPLEMENTS

- A. The supplement listed below, following “End of Section,” is a part of this Specification:
 1. Insulation Type and Thickness Table.

END OF SECTION

Insulation Type and Thickness							
Type	Service	Thickness	Fluid Temp. (°F)	Insulation	Finish Systems		
					Indoors Exposed	Outdoors	Buried
HT—Piping requiring heat tracing.	Per Section 40 05 33, Pipe Heat Tracing.	Pipe Size: Insulation Thickness Inches: * 1/4-3: 1	32-80	Type 2 Insulate and heat trace outside lines 1' above grade. Use Type 3 insulation from 1' above grade to frost depth.	F1	F1 @ Facility 20-Chlorine Dioxide	F4 on Type 3
SU- Sulfuric Acid	Sulfuric Acid	Pipe Size: Insulation Thickness Inches: * 1/4-3: 1	>32	Type 2	F1	F1 @ Facility 20-Chlorine Dioxide	NA
*Inches: Based upon insulation with glass fiber per ASTM C547, no value assigned to cladding or air space at cladding. Matches the watts per foot, wind mph, and percent safety factor as specified in Section 40 05 33, Pipe Heat Tracing. 2012 IECC requires 1-inch minimum thickness							

SECTION 40 80 01
PROCESS PIPING LEAKAGE TESTING

PART 1 GENERAL

1.01 SUBMITTALS

A. Informational Submittals:

1. Testing Plan:
 - a. Submit prior to testing and include at least the information that follows.
 - 1) Testing dates.
 - 2) Piping systems and section(s) to be tested.
 - 3) Test type.
 - 4) Method of isolation.
 - 5) Calculation of maximum allowable leakage for piping section(s) to be tested.
2. Certifications of Calibration: Testing equipment.
3. Certified Test Report.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 PREPARATION

A. Notify Engineer in writing 5 days in advance of testing. Perform testing in presence of Engineer.

B. Pressure Piping:

1. Install temporary thrust blocking or other restraint as necessary to protect adjacent piping or equipment and make taps in piping prior to testing.
2. Wait 5 days minimum after concrete thrust blocking is installed to perform pressure tests. If high-early strength cement is used for thrust blocking, wait may be reduced to 2 days.
3. Prior to test, remove or suitably isolate appurtenant instruments or devices that could be damaged by pressure testing.
4. New Piping Connected to Existing Piping:
 - a. Isolate new piping with grooved-end pipe caps, spectacle blinds, blind flanges, or as acceptable to Engineer.
 - b. Test joint between new piping and existing piping by methods that do not place entire existing system under test load, as approved by Engineer.

5. Items that do not require testing include: Equipment seal drains, tank overflows to atmospheric vented drains, and tank atmospheric vents.
 6. Test Pressure: As indicated on Piping Schedule.
- C. Test section may be filled with water and allowed to stand under low pressure prior to testing.
- D. Gravity Piping:
1. Perform testing after service connections, manholes, and backfilling have been completed between stations to be tested.
 2. Determine groundwater level at time of testing by exploratory holes or other method acceptable to Engineer.

3.02 HYDROSTATIC TEST FOR PRESSURE PIPING

- A. Fluid: Clean water of such quality to prevent corrosion of materials in piping system.
- B. Exposed Piping:
1. Perform testing on installed piping prior to application of insulation.
 2. Maximum Filling Velocity: 0.25 foot per second, applied over full area of pipe.
 3. Vent piping during filling. Open vents at high points of piping system or loosen flanges, using at least four bolts, or use equipment vents to purge air pockets.
 4. Maintain hydrostatic test pressure continuously for 60 minutes, minimum, and for such additional time as necessary to conduct examinations for leakage.
 5. Examine joints and connections for leakage.
 6. Correct visible leakage and retest as specified.
 7. Empty pipe of water prior to final cleaning or disinfection.
- C. Buried Piping:
1. Test after backfilling has been completed.
 2. Expel air from piping system during filling.
 3. Apply and maintain specified test pressure with hydraulic force pump. Valve off piping system when test pressure is reached.
 4. Maintain hydrostatic test pressure continuously for 2 hours minimum, reopening isolation valve only as necessary to restore test pressure.
 5. Determine actual leakage by measuring quantity of water necessary to maintain specified test pressure for duration of test.

6. Maximum Allowable Leakage:

$$L = \frac{SD(P)^{1/2}}{148,000}$$

where:

- L = Allowable leakage, in gallons per hour.
- S = Length of pipe tested, in feet.
- D = Nominal diameter of pipe, in inches.
- P = Test pressure during leakage test, in pounds per square inch.

7. Correct leakage greater than allowable, and retest as specified.

3.03 HYDROSTATIC TEST FOR GRAVITY PIPING

- A. Testing Equipment Accuracy: Plus or minus 1/2-gallon water leakage under specified conditions.
- B. Maximum Allowable Leakage: 0.16 gallon(s) per hour per inch diameter per 100 feet. Include service connection footage in test section, subjected to minimum head specified.
- C. Gravity Sanitary and Roof Drain Piping: Test with 15 feet of water to include highest horizontal vent in filled piping. Where vertical drain and vent systems exceed 15 feet in height, test systems in 15-foot vertical sections as piping is installed.
- D. Exfiltration Test:
 - 1. Hydrostatic Head:
 - a. At least 6 feet above maximum estimated groundwater level in section being tested.
 - b. No less than 6 feet above inside top of highest section of pipe in test section, including service connections.
 - 2. Length of Pipe Tested: Limit length such that pressure on invert of lower end of section does not exceed 30 feet of water column.
- E. Infiltration Test:
 - 1. Groundwater Level: At least 6 feet above inside top of highest section of pipe in test section, including service connections.
- F. Piping with groundwater infiltration rate greater than allowable leakage rate for exfiltration will be considered defective even if pipe previously passed a pressure test.
- G. Defective Piping Sections: Replace and retest as specified.

3.04 FIELD QUALITY CONTROL

A. Test Report Documentation:

1. Test date.
2. Description and identification of piping tested.
3. Test fluid.
4. Test pressure.
5. Remarks, including:
 - a. Leaks (type, location).
 - b. Repair/replacement performed to remedy excessive leakage.
6. Signed by Contractor and Engineer to represent that test has been satisfactorily completed.

END OF SECTION

SECTION 40 90 01 INSTRUMENTATION AND CONTROL FOR PROCESS SYSTEMS

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. ASTM International (ASTM):
 - a. A182, Standard Specification for Forged or Rolled Alloy-Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service.
 - b. A276, Standard Specification for Stainless and Heat-Resisting Steel Bars and Shapes.
 - c. A312, Standard Specification for Seamless and Welded Austenitic Stainless Steel Pipes.
 - d. B32, Standard Specification for Solder Metal.
 - e. B88, Standard Specification for Seamless Copper Water Tube.
2. International Society of Automation (ISA):
 - a. S5.1, Instrumentation Symbols and Identification (NRC ADOPTED).
 - b. PR12.6, Installation of Intrinsically Safe Systems for Hazardous (Classified) Locations.
 - c. S5.4, Standard Instrument Loop Diagrams.
 - d. S20, Specification Forms for Process Measurement and Control Instruments, Primary Elements and Control Valves.
 - e. S50.1, Compatibility of Analog Signals for Electronic Industrial Process Instruments.
3. National Electrical Manufacturers Association (NEMA):
 - a. 250, Enclosures for Electrical Equipment (1,000 Volts Maximum).
 - b. ICS 1, General Standards for Industrial Control and Systems.
4. National Institute of Standards and Technology (NIST).
5. NSF International (NSF):
 - a. NSF/ANSI 61, Drinking Water System Components - Health Effects.
 - b. NSF/ANSI 372, Drinking Water System Components - Lead Content.
6. Underwriters Laboratory, Inc. (UL): 508A, Standard for Safety, Industrial Control Panels.

1.02 SUMMARY

A. Work Includes:

1. Engineering, furnishing, installing, calibrating, adjusting, testing, documenting, starting up, and Owner training for complete Process Instrumentation and Control (PIC) for plant.
2. Major parts are:
 - a. Primary elements, transmitters, control devices and control panels.
 - b. Integration of new Chlorine Dioxide Generation System Controls into the existing Plant PLC Network system via Ethernet TCP/IP.
 - c. Integration of new systems and controls into existing Wonderware HMI system. Create displays as required for the process equipment as depicted on the Contract Drawings. Modify existing graphics as required. Contractor shall follow the existing graphics standards to provide consistent look and feel.
 - d. Application software shall be provided by the Contractor. Work includes but is not limited to, modifications to the existing PLC(s) as required, configuration of the existing servers and PLC networks and additions/modifications to the Wonderware application software.

B. Detailed Design: PIC as shown and specified includes functional and performance requirements and component specifications. Complete detailed PIC design.

C. PIC System Integrator shall be selected from the following list:

1. Kapsch Trafficcom US, Duluth, GA.
2. MR Systems, Norcross, GA.
3. J.K. Duren Company, Roswell, GA.
4. Revere Control Systems, Birmingham, AL.

1.03 DEFINITIONS

A. Abbreviations:

1. CP: Control Panel.
2. FP: Field Panel.
3. HMI: Human Machine Interface.
4. LCP: Local Control Panel.
5. MCC: Motor Control Center.
6. PAT: Performance Acceptance Test.
7. PIC: Process Instrumentation and Control.
8. PLC: Programmable Logic Controller.
9. RIO: Remote Input/Output.
10. RTU: Remote Telemetry Unit.

- B. Rising/Falling: Terms used to define actions of discrete devices about their setpoints.
1. Rising: Contacts close when an increasing process variable rises through setpoint.
 2. Falling: Contacts close when a decreasing process variable falls through setpoint.
- C. Signal Types:
1. Analog Signals, Current Type:
 - a. 4 mA to 20 mA dc signals conforming to ISA S50.1.
 - b. Unless otherwise indicated for specific PIC Subsystem components, use the following ISA 50.1 options:
 - 1) Transmitter Type: Number 2, two-wire.
 - 2) Transmitter Load Resistance Capacity: Class L.
 - 3) Fully isolated transmitters and receivers.
 2. Analog Signals, Voltage Type: 1 to 5 volts dc within panels where a common high precision dropping resistor is used.
 3. Discrete signals, two-state logic signals using dc or 120V ac sources as indicated.
 4. Pulse Frequency Signals:
 - a. Direct current pulses whose repetition rate is linearly proportional to process variable.
 - b. Pulses generated by contact closures or solid state switches as indicated.
 - c. Power source less than 30V dc.
 5. Special Signals: Other types of signals used to transmit analog and digital information between field elements, transmitters, receivers, controllers, and digital devices.
- D. Instrument Tag Numbers:
1. A shorthand tag number notation is used in the Loop Specifications. For example: AI-1-2(2)(3)[pH].
- | Notation | Explanation |
|----------|---|
| AI | ISA designator for Analysis Indicator. |
| 65 | Unit process number. |
| 5 | Loop number. |
| (3) | First unit number; number of same 655-1 component types in a given loop; -1 and -2 in this example. |
2. In this example, PIT-655-(3) is shorthand for: PIT-655-1; PIT-655-2; PIT-655-3.

1.04 SUBMITTALS

A. Action Submittals:

1. General:
 - a. Shop Drawings, full-scaled details, wiring diagrams, catalog cuts, and descriptive literature.
 - b. Identify proposed items and options. Identify installed spares and other provisions for future work (for example, reserved panel space; unused components, wiring, and terminals).
 - c. Legends and Abbreviation Lists: Complete definition of symbols and abbreviations used on this Project (for example, engineering units, flow streams, instruments, structures, and other process items used in nameplates, legends, and data sheets).
2. Bill of Materials: List of required equipment.
 - a. Group equipment items as follows:
 - 1) I&C Components: By component identification code.
 - 2) Other Equipment: By equipment type.
 - b. Data Included:
 - 1) Equipment tag number.
 - 2) Description.
 - 3) Manufacturer, complete model number, and all options not defined by model number.
 - 4) Quantity supplied.
 - 5) Component identification code where applicable.
3. Catalog Cuts: I&C Components, Electrical Devices, and Mechanical Devices:
 - a. Catalog information, mark to identify proposed items and options.
 - b. Descriptive literature.
 - c. External power and signal connections.
 - d. Scaled drawings showing exterior dimensions and locations of electrical and mechanical interfaces.
4. Component Data Sheets: Data sheets for I&C components.
 - a. Format and Level of Detail: In accordance with ISA-S20.
 - b. Include component type identification code and tag number on data sheet.
 - c. Specific features and configuration data for each component:
 - 1) Location or service.
 - 2) Manufacturer and complete model number.
 - 3) Size and scale range.
 - 4) Setpoints.
 - 5) Materials of construction.
 - 6) Options included.
 - d. Name, address, and telephone number of manufacturer's local office, representative, distributor, or service facility.

5. Sizing and Selection Calculations:
 - a. Primary Elements: Complete calculations plus process data used. Example, for flow elements, minimum and maximum values, permanent head loss, and assumptions made.
 - b. Controlling, Computing and Function Generating Modules: Actual scaling factors with units and how they were computed.
6. Panel Construction Drawings:
 - a. Scale Drawings: Show dimensions and location of panel mounted devices, doors, louvers, and subpanels, internal and external.
 - b. Panel Legend: List front of panel devices by tag numbers, nameplate inscriptions, service legends, and annunciator inscriptions.
 - c. Bill of Materials: List devices mounted within panel that are not listed in panel legend. Include tag number, description, manufacturer, and model number.
 - d. Construction Details: NEMA rating, materials, material thickness, structural stiffeners and brackets, lifting lugs, mounting brackets and tabs, door hinges and latches, and welding and other connection callouts and details.
 - e. Construction Notes: Finishes, wire color schemes, wire ratings, wire and terminal block, numbering and labeling scheme.
7. Panel Control Diagrams: For discrete control and power circuits.
 - a. Diagram Type: Ladder diagrams. Include devices, related to discrete functions, that are mounted in or on the panel and that require electrical connections. Show unique rung numbers on left side of each rung.
 - b. Item Identification: Identify each item with attributes listed.
 - 1) Wires: Wire number and color. Cable number if part of multiconductor cable.
 - 2) Terminals: Location (enclosure number, terminal junction box number, or MCC number), terminal strip number, and terminal block number.
 - 3) Discrete Components:
 - a) Tag number, terminal numbers, and location ("FIELD", enclosure number, or MCC number).
 - b) Switching action (open or close on rising or falling process variable), setpoint value and units, and process variable description (for example, Sump Level High).
 - 4) Relay Coils:
 - a) Tag number and its function.
 - b) On right side of run where coil is located, list contact location by ladder number and sheet number. Underline normally closed contacts.
 - 5) Relay Contacts: Coil tag number, function, and coil location (ladder rung number and sheet number).

- c. Show each circuit individually. No “typical” diagrams or “typical” wire lists will be permitted.
 - d. Ground wires, surge protectors, and connections.
 - e. Circuit Names: Show names corresponding to Circuit and Raceway Schedule for circuits entering and leaving a panel. Refer to Division 26, Electrical.
8. Panel Wiring Diagrams: Show point-to-point and terminal-to-terminal wiring within panel.
9. Loop Diagrams: Individual wiring diagram for each analog or pulse frequency loop.
- a. Conform to the minimum requirements of ISA S5.4.
 - b. Under Paragraph 5.3 of ISA S5.4, include the information listed under subparagraphs 2 and 6.
 - c. Drawing Size: Individual 11-inch by 17-inch sheet for each loop.
 - d. Divide each loop diagram into areas for panel face, back-of-panel, and field.
 - e. Show:
 - 1) Terminal numbers, location of dc power supply, and location of common dropping resistors.
 - 2) Switching contacts in analog loops and output contacts of analog devices. Reference specific control diagrams where functions of these contacts are shown.
 - 3) Tabular summary on each diagram:
 - a) Transmitting Instruments: Output capability.
 - b) Receiving Instruments: Input impedance.
 - c) Loop Wiring Impedance: Estimate based on wire sizes and lengths shown.
 - d) Total loop impedance.
 - e) Reserve output capacity.
 - 4) Circuit and raceway schedule names.
10. Interconnecting Wiring Diagrams:
- a. Diagrams, device designations, and symbols in accordance with NEMA ICS 1.
 - b. Diagrams shall bear electrical Subcontractor’s signature attesting diagrams have been coordinated with Division 26, Electrical.
 - c. Show:
 - 1) Electrical connections between equipment, consoles, panels, terminal junction boxes, and field mounted components.
 - 2) Component and panel terminal board identification numbers, and external wire and cable numbers.
 - 3) Circuit names matching Circuit and Raceway Schedule.
 - 4) Intermediate terminations between field elements and panels (for example, to terminal junction boxes and pull boxes).
 - 5) Pull boxes.

- B. Informational Submittals: For PIC equipment, provide Manufacturer's Certificate of Proper Installation and readiness for operation.
1. Owner Training Plan. Reference Section 01 43 33, Manufacturers' Field Services.
 2. Operation and Maintenance (O&M) Manuals: In accordance with Section 01 78 23, Operation and Maintenance Data, unless otherwise specified in this section.
 - a. Content and Format:
 - 1) Complete sets O&M manuals.
 - 2) Sufficient detail to allow operation, removal, installation, adjustment, calibration, maintenance and purchasing replacements for each PIC component.
 - 3) Final versions of Legend and Abbreviation Lists.
 - 4) Manual format in accordance with Section 01 78 23, Operation and Maintenance Data.
 - b. Include:
 - 1) Process and Instrumentation Diagrams: One reproducible copy of revised P&ID to reflect as-built PIC design.
 - 2) Refer to paragraph Shop Drawings for the following items:
 - a) Bill of Materials.
 - b) Catalog Cuts.
 - c) Component Data Sheets.
 - d) Panel Control Diagrams.
 - e) Panel Wiring Diagrams, one reproducible copy.
 - f) Panel Plumbing Diagrams, one reproducible copy.
 - g) Loop Diagrams, one reproducible copy.
 - h) Interconnecting Wiring Diagrams, one reproducible copy.
 - i) Application Software Documentation.
 - 3) Device O&M manuals for components, electrical devices, and mechanical devices include:
 - a) Operations procedures.
 - b) Installation requirements and procedures.
 - c) Maintenance requirements and procedures.
 - d) Troubleshooting procedures.
 - e) Calibration procedures.
 - f) Internal schematic and wiring diagrams.
 - g) Component Calibration Sheets from field quality control calibrations.
 - 4) List of spares, expendables, test equipment and tools provided.
 - 5) List of additional spares, expendables, test equipment and tools recommended.

3. Performance Acceptance Tests (PAT) Submittals:
 - a. Preliminary Test Procedures: Outlines of proposed tests, forms, and checklists.
 - b. Final Test Procedures: Proposed test procedures, forms, and checklists.
 - c. Test Documentation: Copy of signed off test procedures when tests are completed.

1.05 QUALITY ASSURANCE

- A. Calibration Instruments: Each instrument used for calibrating PIC equipment shall bear the seal of a reputable laboratory certifying that instrument has been calibrated within the previous 12 months to a standard endorsed by the NIST.
- B. Coordination Meetings:
 1. In accordance with Section 01 31 13, Project Coordination.
 2. Location: Owner's Site.
 3. Attended By: Engineer, Owner, and Contractor.
 4. Minimum of one is required. Specific dates will be established in Progress Schedule.
 5. First Meeting: Within 36 days after Notice to Proceed.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Provide Site and warehouse storage facilities for PIC equipment.
- B. Prior to shipment, include corrosive-inhibitive vapor capsules in shipping containers, and related equipment as recommended by the capsule manufacturer.
- C. Prior to installation, store items in dry indoor locations. Provide heating in storage areas for items subject to corrosion under damp conditions.
- D. Cover panels and other elements that are exposed to dusty construction environments.

1.07 ENVIRONMENTAL REQUIREMENTS

- A. Standard Environmental Requirements: Unless otherwise noted, design equipment for continuous operation in these environments:
 1. Freestanding Panel and Consoles:
 - a. Inside, Air Conditioned: NEMA 1.
 - b. Inside: NEMA 12.
 - c. Outside: NEMA 4X.

2. Smaller Panels and Assemblies (that are not Freestanding):
 - a. Inside, Air Conditioned: NEMA 12.
 - b. All Other Locations: NEMA 4X.
 3. Field Elements: Outside.
- B. Environmental Design Requirements: Following defines the types of environments referred to in the above.
1. Inside, Air Conditioned:
 - a. Temperature:
 - 1) Normal: 60 to 80 degrees F.
 - 2) With Up to 4-Hour HVAC System Interruptions: 40 to 105 degrees F.
 - b. Relative Humidity:
 - 1) Normal: 10 percent (winter) to 70 percent (summer).
 - 2) With Up to 4-Hour HVAC System Interruption: 10 to 100 percent.
 - c. NEC Classification: Nonhazardous.
 2. Inside:
 - a. Temperature: 20 to 104 degrees F.
 - b. Relative Humidity: 10 to 95 percent noncondensing.
 - c. NEC Classification: Nonhazardous.
 3. Inside, Corrosive:
 - a. Temperature: Minus 20 to 104 degrees F.
 - b. Relative Humidity: 10 to 95 percent noncondensing.
 - c. Corrosive Environment: Chlorine gas.
 - d. NEC Classification: Nonhazardous.
 4. Outside:
 - a. Temperature: Minus 20 to 104 degrees F.
 - b. Relative Humidity: 10 to 95 percent noncondensing, freezing rain.
 - c. NEC Classification: Nonhazardous.
 5. Outside, Corrosive:
 - a. Temperature: Minus 20 to 104 degrees F.
 - b. Relative Humidity: 10 to 95 percent noncondensing, freezing rain.
 - c. Corrosive Environment: Chlorine gas.
 - d. NEC Classification: Nonhazardous.

1.08 SEQUENCING AND SCHEDULING

- A. Activity Completion: The following is a list of key activities and their completion criteria:
1. Shop Drawings: Reviewed and approved.
 2. Quality Control Submittals: Reviewed and accepted.
 3. Hardware Delivery: Hardware delivered to Site and inventoried by Contractor.
 4. PAT: Completed and required test documentation accepted.

- B. PIC Substantial Completion: When Engineer issues Certificate of Substantial Completion.
1. Prerequisites:
 - a. All PIC Submittals have been completed.
 - b. PIC has successfully completed PAT.
 - c. Owner training plan is on schedule.
 - d. All spares, expendables, and test equipment have been delivered to Owner.
- C. PIC Acceptance: When Engineer issues a written notice of Final Payment and Acceptance.
1. Prerequisites:
 - a. Certificate of Substantial Completion issued for PIC.
 - b. Punch-list items completed.
 - c. Final revisions to O&M manuals accepted.
 - d. Maintenance service agreements for PIC accepted by Owner.
- D. Prerequisite Activities and Lead Times: Do not start the following key Project activities until the prerequisite activities and lead times listed below have been completed and satisfied:

Activity	Prerequisites and Lead Times
Submittal reviews by Engineer	Engineer acceptance of Submittal breakdown and schedule.
Hardware purchasing, fabrication, and assembly	Associated Shop Drawing Submittals completed.
Shipment	Completion of PIC Shop Drawing Submittals and preliminary O&M manuals.
Owner Training	Owner training plan completed.
PAT	Startup, Owner training, and PAT procedures completed; notice 4 weeks prior to start.

PART 2 PRODUCTS

2.01 GENERAL

- A. PIC functions as shown on Drawings and as required for each loop. Furnish equipment items as required. Furnish all materials, equipment, and software, necessary to effect required system and loop performance.

- B. First Named Manufacturer: PIC design is based on first named manufacturers of equipment and materials.
 - 1. If an item is proposed from other than first named manufacturer, obtain approval from Engineer for such changes in accordance with Article Submittals.
 - 2. If using proposed item requires other changes, provide work and equipment to implement these changes. Changes that may be required include, but are not limited to: different installation, wiring, raceway, enclosures, connections, isolators, intrinsically safe barriers, software, and accessories.
- C. Like Equipment Items:
 - 1. Use products of one manufacturer and of the same series or family of models to achieve standardization for appearance, operation, maintenance, spare parts, and manufacturer's services.
 - 2. Implement all same or similar functions in same or similar manner. For example, control logic, sequence controls, and display layouts.
- D. Components and Materials in Contact with Water for Human Consumption: Comply with the requirements of the Safe Drinking Water Act and other applicable federal, state, and local requirements. Provide certification by manufacturer or an accredited certification organization recognized by the Authority Having Jurisdiction that components and materials comply with the maximum lead content standard in accordance with NSF/ANSI 61 and NSF/ANSI 372. Use or reuse of components and materials without a traceable certification is prohibited.

2.02 LOOP SPECIFICATIONS

- A. Location: Article Supplements.
- B. Organization: By unit process and loop number.
- C. Functional Requirements for Control Loops:
 - 1. Shown on Drawings, in Panel Control Diagrams, and Process and Instrumentation Diagrams (P&ID). P&ID format and symbols are in accordance with ISA S5.1, except as specified or shown on Drawings.
 - 2. Supplemented by Loop Specifications.

D. Subheadings for Each Loop:

1. Functions: Clarifies functional performance of loop, including abstract of interlocks.
 - a. Components: Lists major components for each loop. Information listed includes tag numbers.
 - b. Component Identification Codes: Alphanumeric codes of required components. Refer to Component Specification referenced in Article Supplements.
 - c. Component Names and Options: Required to tailor general Component Specifications to specific application. For example, special materials, mounting, size, unit range, scale, setpoints, and controller options.

2.03 NAMEPLATES AND TAGS

A. Panel Nameplates: Enclosure identification located on the enclosure face.

1. Location and Inscription: As shown.
2. Materials: Laminated plastic attached to panel with stainless steel screws.
3. Letters: 1/2-inch white on black background, unless otherwise noted.

B. Component Nameplates—Panel Face: Component identification located on panel face under or near component.

1. Location and Inscription: As shown.
2. Materials: Laminated plastic attached to panel with stainless steel screws.
3. Letters: 3/16-inch white on black background, unless otherwise noted.

C. Component Nameplates—Back of Panel: Component identification located on or near component inside of enclosure.

1. Inscription: Component tag number.
2. Materials: Adhesive backed, laminated plastic.
3. Letters: 3/16-inch white on black background, unless otherwise noted.

D. Legend Plates for Panel Mounted Pushbuttons, Lights, and Switches:

1. Inscription: Refer to:
 - a. Table under paragraph Standard Pushbutton Colors and Inscriptions.
 - b. Table under paragraph Standard Light Colors and Inscriptions.
 - c. P&IDs in Drawings.

2. Materials: Stainless steel, keyed legend plates. Secured to panel by mounting nut for pushbutton, light, or switch.
 3. Letters: Black on gray or white background.
- E. Service Legends: Component identification nameplate located on face of component.
1. Inscription: As shown.
 2. Materials: Adhesive backed, laminated plastic.
 3. Letters: 3/16-inch white on black background, unless otherwise noted.
- F. Nametags: Component identification for field devices.
1. Inscription: Component tag number.
 2. Materials: 16-gauge, Type 304 stainless steel.
 3. Letters: 3/16-inch imposed.
 4. Mounting: Affix to component with 16- or 18-gauge stainless steel wire or stainless steel screws.

2.04 ELECTRICAL REQUIREMENTS

- A. In accordance with Division 26, Electrical.
- B. I&C and electrical components, terminals, wires, and enclosures: UL recognized or UL listed.
- C. Wires Within Enclosures:
1. ac Circuits:
 - a. Type: 300-volt, Type MTW stranded copper.
 - b. Size: For current to be carried, but not less than 18 AWG.
 2. Analog Signal Circuits:
 - a. Type: 300-volt stranded copper, twisted shielded pairs.
 - b. Size: 18 AWG, minimum.
 3. Other dc Circuits.
 - a. Type: 300-volt, Type MTW stranded copper.
 - b. Size: For current carried, but not less than 18 AWG.
 4. Special Signal Circuits: Use manufacturer's standard cables.
 5. Wire Identification: Numbered and tagged at each termination.
 - a. Wire Tags: Machine printed, heat shrink.
 - b. Manufacturers:
 - 1) Brady PermaSleeve.
 - 2) Tyco Electronics.

- D. Wires entering or leaving enclosures, terminate and identify as follows:
1. Analog and discrete signal, terminate at numbered terminal blocks.
 2. Special signals, terminated using manufacturer's standard connectors.
 3. Identify wiring in accordance with Division 26, Electrical.
- E. Terminal Blocks for Enclosures:
1. Quantity:
 - a. Accommodate present and spare indicated needs.
 - b. Wire spare PLC and RTU I/O points to terminal blocks.
 - c. One wire per terminal for field wires entering enclosures.
 - d. Maximum of two wires per terminal for 18-WG wire for internal enclosure wiring.
 - e. Spare Terminals: 20 percent of all connected terminals, but not less than 5 per terminal block.
 2. General:
 - a. Connection Type: Screw compression clamp.
 - b. Compression Clamp:
 - 1) Complies with DIN-VDE 0611.
 - 2) Hardened steel clamp with transversal grooves that penetrate wire strands providing a vibration-proof connection.
 - 3) Guides strands of wire into terminal.
 - c. Screws: Hardened steel, captive and self-locking.
 - d. Current Bar: Copper or treated brass.
 - e. Insulation:
 - 1) Thermoplastic rated for minus 55 to plus 110 degree C.
 - 2) Two funneled shaped inputs to facilitate wire entry.
 - f. Mounting:
 - 1) Standard DIN rail.
 - 2) Terminal block can be extracted from an assembly without displacing adjacent blocks.
 - 3) End Stops: Minimum of one at each end of rail.
 - g. Wire preparation: Stripping only permitted.
 - h. Jumpers: Allow jumper installation without loss of space on terminal or rail.
 - i. Marking System:
 - 1) Terminal number shown on both sides of terminal block
 - 2) Allow use of preprinted and field marked tags.
 - 3) Terminal strip numbers shown on end stops.
 - 4) Mark terminal block and terminal strip numbers as shown on Panel Control Diagrams and Loop Diagrams.
 - 5) Fuse Marking for Fused Terminal Blocks: Fuse voltage and amperage rating shown on top of terminal block.

3. Terminal Block, General-Purpose:
 - a. Rated Voltage: 600V ac.
 - b. Rated Current: 30 amp.
 - c. Wire Size: 22 AWG to 10 AWG.
 - d. Rated Wire Size: 10 AWG.
 - e. Color: Grey body.
 - f. Spacing: 0.25 inch, maximum.
 - g. Test Sockets: One screw test socket 0.079-inch diameter.
 - h. Manufacturer and Product: Entrelec; Type M4/6.T.
4. Terminal Block, Ground:
 - a. Wire Size: 22 AWG to 12 AWG.
 - b. Rated Wire Size: 12 AWG.
 - c. Color: Green and yellow body.
 - d. Spacing: 0.25 inch, maximum.
 - e. Grounding: Ground terminal blocks electrically grounded to the mounting rail.
 - f. Manufacturer and Product: Entrelec; Type M4/6.P.
5. Terminal Block, Fused, 24V dc:
 - a. Rated Voltage: 600V dc.
 - b. Rated Current: 16-amp.
 - c. Wire Size: 22 AWG to 10 AWG.
 - d. Rated Wire Size: 10 AWG.
 - e. Color: Grey body.
 - f. Fuse: 0.25 inch by 1.25 inches.
 - g. Indication: LED diode 24V dc.
 - h. Spacing: 0.512 inch, maximum.
 - i. Manufacturer and Product: Entrelec; Type M10/13T.SFL.
6. Terminal Block, Fused, 120V ac:
 - a. Rated Voltage: 600V ac.
 - b. Rated Current: 16-amp.
 - c. Wire Size: 22 AWG to 10 AWG.
 - d. Rated Wire Size: 10 AWG.
 - e. Color: Grey body.
 - f. Fuse: 0.25 inch by 1.25 inches.
 - g. Indication: Neon Lamp 110V ac.
 - h. Leakage Current: 1.8 mA, maximum.
 - i. Spacing: 0.512 inch, maximum
 - j. Manufacturer and Product: Entrelec; Type M10/13T.SFL.

F. Grounding of Enclosures:

1. Furnish isolated copper grounding bus for signal and shield ground connections.
2. Ground bus grounded at a common signal ground point in accordance with National Electrical Code requirements.

3. Single Point Ground for Each Analog Loop:
 - a. Locate at dc power supply for loop.
 - b. Use to ground wire shields for loop.
 4. Ground terminal block rails to ground bus.
- G. Analog Signal Isolators: Furnish signal isolation for analog signals that are sent from one enclosure to another. Do not wire in series instruments on different panels, cabinets, or enclosures.
- H. Power Distribution Within Panels:
1. Feeder Circuits:
 - a. One or more 120V ac, 60-Hz feeder circuits as shown on Drawings.
 - b. Make provisions for feeder circuit conduit entry.
 - c. Furnish terminal board for termination of wires.
 2. Power Panel: Furnish main circuit breaker and a circuit breaker on each individual branch circuit distributed from power panel.
 - a. Locate to provide clear view of and access to breakers when door is open.
 - b. Breaker Sizes: Coordinate such that fault in branch circuit will blow only branch breaker but not trip the main breaker.
 - 1) Branch Circuit Breaker: 15 amps at 250V ac.
 - c. Breaker Manufacturers and Products: Refer to Division 26, Electrical.
 3. Circuit Wiring: P&IDs and Control Diagrams on Drawings show function only. Use following rules for actual circuit wiring:
 - a. Devices on Single Circuit: 20, maximum.
 - b. Multiple Units Performing Parallel Operations: To prevent failure of any single branch circuit from shutting down entire operation, do not group all units on same branch circuit.
 - c. Branch Circuit Loading: 12 amperes continuous, maximum.
 - d. Panel Lighting and Service Outlets: Put on separate 15-amp, 120V ac branch circuit.
 - e. Provide 120V ac plugmold for panel components with line cords.
- I. Signal Distribution:
1. Within Panels: 4 mA to 20 mA dc signals may be distributed as 1 to 5V dc.
 2. Outside Panels: Isolated 4 mA to 20 mA dc only.
 3. All signal wiring twisted in shielded pairs.

J. Relays:

1. General:
 - a. Relay Mounting: Plug-in type socket.
 - b. Relay Enclosure: Furnish dust cover.
 - c. Socket Type: Screw terminal interface with wiring.
 - d. Socket Mounting: Rail.
 - e. Provide holddown clips.
2. Signal Switching Relay:
 - a. Type: Dry circuit.
 - b. Contact Arrangement: 2 Form C contacts.
 - c. Contact Rating: 0 to 5 amps at 28V dc or 120V ac.
 - d. Contact Material: Gold or silver.
 - e. Coil Voltage: As noted or shown.
 - f. Coil Power: 0.9 watts (dc), 1.2VA (ac).
 - g. Expected Mechanical Life: 10,000,000 operations.
 - h. Expected Electrical Life at Rated Load: 100,000 operations.
 - i. Indication Type: Neon or LED indicator lamp.
 - j. Seal Type: Hermetically sealed case.
 - k. Manufacturer and Product: Potter and Brumfield; Series KH/KHA.
3. Control Circuit Switching Relay, Nonlatching:
 - a. Type: Compact general-purpose plug-in.
 - b. Contact Arrangement: 3 Form C contacts.
 - c. Contact Rating: 10A at 28V dc or 240V ac.
 - d. Contact Material: Silver cadmium oxide alloy.
 - e. Coil Voltage: As noted or shown.
 - f. Coil Power: 1.8 watts (dc), 2.7VA (ac).
 - g. Expected Mechanical Life: 10,000,000 operations.
 - h. Expected Electrical Life at Rated Load: 100,000 operations.
 - i. Indication Type: Neon or LED indicator lamp.
 - j. Push to test button.
 - k. Manufacturer and Product: Potter and Brumfield; Series KUP.

K. Power Supplies:

1. Furnish to power instruments requiring external dc power, including two-wire transmitters and dc relays.
2. Convert 120V ac, 60-Hz power to dc power of appropriate voltage(s) with sufficient voltage regulation and ripple control to assure that instruments being supplied can operate within their required tolerances.
3. Provide output over voltage and over current protective devices to:
 - a. Protect instruments from damage due to power supply failure.
 - b. Protect power supply from damage due to external failure.
4. Enclosures: NEMA 1 in accordance with NEMA 250.

5. Mount such that dissipated heat does not adversely affect other components.
6. Fuses: For each dc supply line to each individual two-wire transmitter.
 - a. Type: Indicating.
 - b. Mount so fuses can be easily seen and replaced.

L. Internal Panel Lights for Freestanding Panels:

1. Type: Switched 100-watt incandescent back-of-panel lights.
2. Quantity: One light for every 4 feet of panel width.
3. Mounting: Inside and in the top of back-of-panel area.
4. Protective metal shield for lights.

M. Service Outlets for Freestanding Panels:

1. Type: Three-wire, 120-volt, 15-ampere, GFCI duplex receptacles.
2. Quantity:
 - a. For panels 4 feet wide and smaller: One.
 - b. For panels wider than 4 feet: One for every 4 feet of panel width, two minimum per panel.
3. Mounting: Evenly spaced along back-of-panel area.

N. Internal Panel Lights and Service Outlets for Smaller Panels:

1. Internal Panel Light: Switched 100-watt incandescent light.
2. Service Outlet: Breaker protected 120-volt, 15-amp, GFCI duplex receptacle:
3. Required for all following panels.

O. Standard Pushbutton Colors and Inscriptions: Use following color code and inscriptions for pushbuttons, unless otherwise noted on Drawings.

Tag Function	Inscription(s)	Color
OO	ON OFF	Black Black
OC	OPEN CLOSE	Black Black
OCA	OPEN CLOSE AUTO	Black Black Black
OOA	ON OFF AUTO	Black Black Black
MA	MANUAL AUTO	Black Black

Tag Function	Inscription(s)	Color
SS	START STOP	Black Black
RESET	RESET	Black
EMERGENCY STOP	EMERGENCY STOP	Red

1. Lettering Color:
 - a. Black on white and yellow buttons.
 - b. White on black, red, and green buttons.
- P. Standard Light Colors and Inscriptions: Use following color code and inscriptions for service legends and lens colors for indicating lights, unless otherwise noted on Drawings.

Tag Function	Inscription(s)	Color
ON	ON	Red
OFF	OFF	Green
OPEN	OPEN	Red
CLOSED	CLOSED	Green
LOW	LOW	Green
FAIL	FAIL	Amber
HIGH	HIGH	Red
AUTO	AUTO	White
MANUAL	MANUAL	Yellow
LOCAL	LOCAL	White
REMOTE	REMOTE	Yellow

1. Lettering Color:
 - a. Black on white and amber lenses.
 - b. White on red and green lenses.

2.05 SPARE PARTS

Description	Percent of Each Type and Size Used	No Less Than
dc power supplies	20	2
Fuses	20	5
Indicating light bulb	20	10
Relays	20	3

Description	Percent of Each Type and Size Used	No Less Than
Terminal Blocks	10	10
Hand Switches	10	5

2.06 FABRICATION

A. General:

1. Panels with external dimensions and instruments arrangement as shown on Drawings.
2. Panel Construction and Interior Wiring: In accordance with the National Electrical Code, state and local codes, NEMA, ANSI, UL, and ICECA.
3. Fabricate panels, install instruments, wire, and plumb, at the PIC factory.
4. Electrical Work: In accordance with Division 26, Electrical.

B. Factory Assembly: Assemble panels at the manufacturer's factory. No fabrication other than correction of minor defects or minor transit damage shall be done on panels at Site.

C. UL Listing Mark for Enclosures: Mark stating "Listed Enclosed Industrial Control Panel" per UL 508A.

D. Wiring Within PIC Panels:

1. Restrain by plastic ties or ducts or metal raceways.
2. Hinge Wiring: Secure at each end so that bending or twisting will be around longitudinal axis of wire. Protect bend area with sleeve.
3. Arrange wiring neatly, cut to proper length, and remove surplus wire.
4. Abrasion protection for wire bundles which pass through holes or across edges of sheet metal.
5. Connections to Screw Type Terminals:
 - a. Locking-fork-tongue or ring-tongue lugs.
 - b. Use manufacturer's recommended tool with required sized anvil to make crimp lug terminations.
 - c. Wires terminated in a crimp lug, maximum of one.
 - d. Lugs installed on a screw terminal, maximum of two.
6. Connections to Compression Clamp Type Terminals:
 - a. Strip, prepare, and install wires in accordance with terminal manufacturer's recommendations.
 - b. Wires installed in a compression screw and clamp, maximum of one for field wires entering enclosure, otherwise maximum of two.
7. Splicing and tapping of wires, allowed only at device terminals or terminal blocks.

8. Terminate 24V dc and analog signal circuits on separate terminal block from ac circuit terminal blocks.
9. Separate analog and dc circuits by at least 6 inches from ac power and control wiring, except at unavoidable crossover points and at device terminations.
10. Arrange wiring to allow access for testing, removal, and maintenance of circuits and components.
11. Plastic Wire Ducts Fill: Do not exceed manufacturer's recommendation.

E. Temperature Control:

1. Freestanding Panels:
 - a. Non-ventilated Panels: Size to adequately dissipate heat from equipment mounted inside panel or on panel.
 - b. Ventilated Panels:
 - 1) Furnish with louvers and forced ventilation as required to prevent temperature buildup from equipment mounted inside panel or on panel.
 - 2) For panels with backs against wall, furnish louvers on top and bottom of panel sides.
 - 3) For panels without backs against wall, furnish louvers on top and bottom of panel back.
 - 4) Louver Construction: Stamped sheet metal.
 - 5) Ventilation Fans:
 - a) Furnish where required to provide adequate cooling.
 - b) Create positive internal pressure within panel.
 - c) Fan Motor Power: 120V ac, 60-Hz, thermostatically controlled.
 - 6) Air Filters: Washable aluminum, Hoffman Series A-FLT.
2. Refrigerated System: Furnish where heat dissipation cannot be adequately accomplished with natural convection or forced ventilation. Smaller Panels (that are not freestanding): Size to adequately dissipate heat from equipment mounted inside panel or in panel face.
3. Space Heaters:
 - a. Thermostatically controlled to maintain internal panel temperatures above dew point.
 - b. Required for following panels: All.

F. Freestanding Panel Construction:

1. Materials: Sheet steel, unless otherwise shown on Drawings with minimum thickness of 10-gauge, unless otherwise noted.
2. Panel Fronts:
 - a. Fabricated from a single piece of sheet steel, unless otherwise shown on Drawings.
 - b. No seams or bolt heads visible when viewed from front.

- c. Panel Cutouts: Smoothly finished with rounded edges.
- d. Stiffeners: Steel angle or plate stiffeners or both on back of panel face to prevent panel deflection under instrument loading or operation.
- 3. Internal Framework:
 - a. Structural steel for instrument support and panel bracing.
 - b. Permit panel lifting without racking or distortion.
- 4. Lifting rings to allow simple, safe rigging and lifting of panel during installation.
- 5. Adjacent Panels: Securely bolted together so front faces are parallel.
- 6. Doors: Full height, fully gasketed access doors where shown on Drawings.
 - a. Latches: Three-point, Southco Type 44.
 - b. Handles: "D" ring, foldable type.
 - c. Hinges: Full length, continuous, piano type, steel hinges with stainless steel pins.
 - d. Rear Access Doors: Extend no further than 24 inches beyond panel when opened to 90-degree position.
 - e. Front and Side Access Doors: As shown on Drawings.

G. Non-freestanding Panel Construction:

- 1. Based on environmental design requirements required and referenced in Article Environmental Requirements, provide the following:
 - a. For panels listed as inside, air conditioned:
 - 1) Enclosure Type: NEMA 12 in accordance with NEMA 250.
 - 2) Materials: Steel.
 - b. For all other panels:
 - 1) Enclosure Type: NEMA 4X in accordance with NEMA 250.
 - 2) Materials: Type 316 stainless steel.
- 2. Metal Thickness: 14-gauge, minimum.
- 3. Doors:
 - a. Rubber-gasketed with continuous hinge.
 - b. Stainless steel lockable quick-release clamps.
- 4. Manufacturers:
 - a. Hoffman Engineering Co.
 - b. Rittal.

H. Factory Finishing:

- 1. Enclosures:
 - a. Stainless Steel and Aluminum: Not painted.
 - b. Nonmetallic Panels: Not painted.
 - c. Steel Panels:
 - 1) Sand panel and remove mill scale, rust, grease, and oil.
 - 2) Fill imperfections and sand smooth.

- 3) Paint panel interior and exterior with one coat of epoxy coating metal primer, two finish coats of two-component type epoxy enamel.
- 4) Sand surfaces lightly between coats.
- 5) Dry Film Thickness: 3 mils, minimum.
2. Manufacturer's standard finish color, except where specific color is indicated. If manufacturer has no standard color, finish equipment with light gray color.

2.07 CORROSION PROTECTION

A. Corrosion-Inhibiting Vapor Capsule Manufacturers:

1. Northern Instruments; Model Zerust VC.
2. Hoffmann Engineering Co; Model A-HCI.

2.08 SOURCE QUALITY CONTROL

- A. Scope: Inspect and test entire PIC to ensure it is ready for shipment, installation, and operation.
- B. Location: Manufacturer's factory or Engineer approved staging Site.
- C. Test: Exercise and test all functions.
- D. Temporary PLC software configuring to allow PLC testing.

2.09 ELECTRICAL TRANSIENT PROTECTION

A. General:

1. Function: Protect elements of PIC against damage due to electrical transients induced in interconnecting lines by lightning and nearby electrical systems.
2. Implementation: Provide, install, coordinate, and inspect grounding of surge suppressors at:
 - a. Connection of ac power to PIC equipment including panels, consoles assemblies, and field mounted analog transmitters and receivers.
 - b. At the field and panel, console, or assembly connection of signal circuits that have portions of the circuit extending outside of a protective building.
3. Construction: First-stage high energy metal oxide varistor and second-stage bipolar silicon avalanche device separated by series impedance. Includes grounding wire, stud, or terminal.
4. Response: 5 nanoseconds maximum.
5. Recovery: Automatic.
6. Temperature Range: Minus 20 degrees C to plus 85 degrees C.

B. Suppressors on 120V ac Power Supply Connections:

1. Occurrences: Tested and rated for a minimum of 50 occurrences of IEEE 587 Category B test waveform.
2. First-Stage Clamping Voltage: 350 volts or less.
3. Second-Stage Clamping Voltage: 210 volts or less.
4. Continuous Operation: Power supplies for one four-wire transmitter or receiver: 5 amps minimum at 130V ac. All other applications: 30 amps minimum at 130V ac.

C. Suppressors on Analog Signal Lines:

1. Test Waveform: Linear 8 microsecond rise in current from 0 amps to a peak current value followed by an exponential decay of current reaching one half the peak value in 20 microseconds.
2. Surge Rating: Tested and rated for 50 occurrences of 2,000-amp peak test waveform.
 - a. dc Clamping Voltage: 20 to 40 percent above operating voltage for circuit.
 - b. dc Clamping Voltage Tolerance: Less than plus or minus 10 percent.
 - c. Maximum Loop Resistance: 18 ohms per conductor.

D. Physical Characteristics:

1. Mounted in Enclosures: Encapsulated in flame retardant epoxy.
2. For Analog Signals Lines: EDCO PC-642 or SRA-64 series.
3. For 120V ac Lines: EDCO HSP-121.
4. Field Mounted at Two-Wire Instruments: Encapsulated in stainless steel pipe nipples. EDCO SS64 series.
5. Field Mounted at Four-Wire Instruments: With 120V ac outlet, ac circuit breaker, and 10-ohm resistors on signal lines, all in enclosure.
 - a. Enclosure: NEMA 4X fiberglass or Type 316 stainless steel with door.
 - 1) Maximum Size: 12 inches by 12 inches by 8 inches deep.
 - b. Manufacturer and Product: EDCO; SLAC series.

E. Installation and Grounding of Suppressors: As shown. See Surge Suppressor Installation Details. Grounding equipment, installation of grounding equipment, and terminations for field mounted devices are provided under Division 26, Electrical.

PART 3 EXECUTION

3.01 EXAMINATION

- A. For equipment not provided by PIC, but that directly interfaces with the PIC, verify the following conditions:
 - 1. Proper installation.
 - 2. Calibration and adjustment of positioners and I/P transducers.
 - 3. Correct control action.
 - 4. Switch settings and dead bands.
 - 5. Opening and closing speeds and travel stops.
 - 6. Input and output signals.

3.02 INSTALLATION

- A. Material and Equipment Installation: Retain a copy of manufacturers' instructions at Site, available for review at all times.
- B. Electrical Wiring: As specified in Division 26, Electrical.
- C. Mechanical Systems:
 - 1. Drawings for PIC Mechanical Systems are diagrammatic and not intended to specifically define element locations or piping and tubing run lengths. Base materials and installations on field measurements.
 - 2. Copper and Stainless Steel Tubing Support: Continuously supported by an aluminum tubing raceway system.
 - 3. Plastic Tubing Supports: Except as shown on Drawings, provide continuous support in conduits or by aluminum tubing raceway system.
 - 4. Install tubing conduit for plastic tubing and tubing raceways parallel with, or at right angles to, structural members of buildings. Make vertical runs straight and plumb.
 - 5. Tubing and Conduit Bends:
 - a. Tool-formed without flattening, and all of same radius.
 - b. Bend Radius: Equal to or larger than conduit and tubing manufacturer's recommended minimum bend radius.
 - c. Slope instrument connection tubing in accordance with installation details.
 - d. Do not run liquid filled instrument tubing immediately over or within a 3-foot plan view clearance of electrical panels, motor starters, or mechanical mounting panel without additional protection. Where tubing must be located in these zones, shield electrical device to prevent water access to electrical equipment.
 - e. Straighten coiled tubing by unrolling on flat surface. Do not pull to straighten.

- f. Cut tubing square with sharp tubing cutter. Deburr cuts and remove chips. Do not gouge or scratch surface of tubing.
- g. Blow debris from inside of tubing.
- h. Make up and install fittings in accordance with manufacturer's recommendations. Verify makeup of tube fittings with manufacturer's inspection gauge.
- i. Use lubricating compound or TFE tape on stainless steel threads to prevent seizing or galling.
- j. Run tubing to allow, for example, clear access to doors, controls, and control panels; and to allow for easy removal of equipment.
- k. Provide separate support for components in tubing runs.
- l. Supply expansion loops and use adapters at pipe, valve, or component connections for proper orientation of fitting.
- m. Keep tubing and conduit runs at least 12 inches from hot pipes.
- n. Locate and install tubing raceways in accordance with manufacturer's recommendations. Locate tubing to prevent spillage, overflow, or dirt from above.
- o. Securely attach tubing raceways to building structural members.
- 6. Enclosure Lifting Rings: Remove rings following installation and plug holes.

D. Removal or Relocation of Materials and Equipment:

- 1. Remove from Site materials that were part of the existing facility but are no longer used, unless otherwise directed by Engineer to deliver to Owner.
- 2. Repair affected surfaces to conform to type, quality, and finish of surrounding surface.

3.03 FIELD FINISHING

- A. Refer to Section 09 90 00, Painting and Coatings.

3.04 FIELD QUALITY CONTROL

A. Startup and Testing Team:

- 1. Thoroughly inspect installation, termination, and adjustment for components and systems.
- 2. Complete onsite tests.
- 3. Complete onsite training.
- 4. Provide startup assistance.

- B. Operational Readiness Inspections and Calibrations: Prior to startup, inspect and test to ensure that entire PIC is ready for operation.
1. Loop/Component Inspections and Calibrations:
 - a. Check PIC for proper installation, calibration, and adjustment on a loop-by-loop and component-by-component basis.
 - b. Prepare component calibration sheet for each active component (except simple hand switches, lights, gauges, and similar items).
 - 1) Project name.
 - 2) Loop number.
 - 3) Component tag number.
 - 4) Component code number.
 - 5) Manufacturer for elements.
 - 6) Model number/serial number.
 - 7) Summary of functional requirements, for example:
 - a) Indicators and recorders, scale and chart ranges.
 - b) Transmitters/converters, input and output ranges.
 - c) Computing elements' function.
 - d) Controllers, action (direct/reverse) and control modes (PID).
 - e) Switching elements, unit range, differential (fixed/adjustable), reset (auto/manual).
 - 8) Calibrations, for example:
 - a) Analog Devices: Actual inputs and outputs at 0, 10, 50, and 100 percent of span, rising and falling.
 - b) Discrete Devices: Actual trip points and reset points.
 - c) Controllers: Mode settings (PID).
 - 9) Space for comments.
 - c. These inspections and calibrations will be spot checked by Engineer.
- C. Performance Acceptance Tests (PAT): These are the activities that Section 01 91 14, Equipment Testing and Facility Startup, refers to as Performance Testing.
1. General:
 - a. Test all PIC elements to demonstrate that PIC satisfies all requirements.
 - b. Test Format: Cause and effect.
 - 1) Person conducting test initiates an input (cause).
 - 2) Specific test requirement is satisfied if correct result (effect) occurs.
 - c. Procedures, Forms, and Checklists:
 - 1) Conduct tests in accordance with, and documented on, Engineer accepted procedures, forms, and checklists.
 - 2) Describe each test item to be performed.

- 3) Have space after each test item description for sign off by appropriate party after satisfactory completion.
 - d. Required Test Documentation: Test procedures, forms, and checklists. All signed by Engineer and Contractor.
 - e. Conducting Tests:
 - 1) Provide special testing materials, equipment, and software.
 - 2) Wherever possible, perform tests using actual process variables, equipment, and data.
 - 3) If it is not practical to test with real process variables, equipment, and data, provide suitable means of simulation.
 - 4) Define simulation techniques in test procedures.
 - f. Coordinate PIC testing with Owner and affected Subcontractors.
 - 1) Excessive Test Witnessing: Refer to Supplementary Conditions.
2. Test Requirements:
- a. Once facility has been started up and is operating, perform a witnessed PAT on complete PIC to demonstrate that it is operating as required. Demonstrate each required function on a paragraph-by-paragraph and loop-by-loop basis.
 - b. Perform local and manual tests for each loop before proceeding to remote and automatic modes.
 - c. Where possible, verify test results using visual confirmation of process equipment and actual process variable. Unless otherwise directed, exercise and observe devices supplied by others, as needed to verify correct signals to and from such devices and to confirm overall system functionality. Test verification by means of disconnecting wires or measuring signal levels is acceptable only where direct operation of plant equipment is not possible.
 - d. Make updated versions of documentation required for PAT available to Engineer at Site, both before and during tests.
 - e. Make one copy of O&M manuals available to Engineer at the Site both before and during testing.
 - f. Refer to referenced examples of PAT procedures and forms in Article Supplements.

3.05 TRAINING

A. General:

1. Provide an integrated training program to meet specific needs of Owner's personnel.
2. Include training sessions, classroom and field, for managers, engineers, operators, and maintenance personnel.
3. Provide instruction on one working shift(s) as needed to accommodate the Owner's personnel schedule.
4. Owner reserves the right to make and reuse video tapes of training sessions.

B. Operations and Maintenance Training:

1. Include a review of O&M manuals and survey of spares, expendables, and test equipment.
2. Use equipment similar to that provided or currently owned by Owner.
3. Provide training suitable for instrument technicians with at least a 2-year associate engineering or technical degree, or equivalent education and experience in electronics or instrumentation.

C. Operations Training:

1. Training Session Duration: One 8-hour instructor days per site.
2. Number of Training Sessions: One per site.
3. Location: Sites.
4. Content: Conduct training on loop-by-loop basis.
 - a. Loop Functions: Understanding of loop functions, including interlocks for each loop.
 - b. Loop Operation: For example, adjusting process variable setpoints, AUTO/MANUAL control transfer, AUTO and MANUAL control, annunciator acknowledgement and resetting.
 - c. Interfaces with other control systems.

D. Maintenance Training:

1. Training Session Duration: One 8-hour instructor days per site.
2. Number of Training Sessions: One per site.
3. Location: Project Sites.
4. Content: Provide training for each type of component and function provided.
 - a. Loop Functions: Understanding details of each loop and how they function.
 - b. Component calibration.
 - c. Adjustments: For example, controller tuning constants, current switch trip points, and similar items.
 - d. Troubleshooting and diagnosis for components.
 - e. Replacing lamps, chart paper, fuses.
 - f. Component removal and replacement.
 - g. Periodic maintenance.

3.06 CLEANING/ADJUSTING

- A. Repair affected surfaces to conform to type, quality, and finish of surrounding surface.

B. Cleaning:

1. Prior to closing system using tubing, clear tubing of interior moisture and debris.
2. Upon completion of Work, remove materials, scraps, and debris from interior and exterior of equipment.

3.07 PROTECTION

- A. Protect enclosures and other equipment containing electrical, instrumentation and control devices, including spare parts, from corrosion through the use of corrosion-inhibiting vapor capsules.
- B. Periodically replace capsules in accordance with capsule manufacturer's recommendations. Replace capsules just prior to Final Payment and Acceptance.

3.08 SUPPLEMENTS

- A. Supplements listed below, following "End of Section," are part of this Specification.
 1. Component Specifications.
 2. Instrument and Control Panel List.
 3. Loop Specifications.
 4. PLC Input and Output List.
 5. Instrument Calibration Sheet: Provides detailed information on each instrument (except simple hand switches, lights, and similar items).
 6. I&C Valve Adjustment Sheet: Each sheet shows detailed information for installation, adjustment, and calibration of a given valve.
 7. Performance Acceptance Test Sheet: Describes the PAT for a given loop. The format is mostly free form.
 - a. Lists the requirements of the loop.
 - b. Briefly describes the test.
 - c. Cites expected results.
 - d. Provides space for check off by witness.

END OF SECTION

COMPONENT SPECIFICATIONS

A. L5 Level Element and Transmitter, Ultrasonic:

1. General:
 - a. Function: Continuous, non-contacting level measurement.
 - b. Type: Ultrasonic.
 - c. Parts: Element, transmitter, interconnecting cable, and accessories as noted.
2. Service:
 - a. Application: Chemical Storage Tanks; refer to instrument list for details.
 - b. Vapor Space Pressure: Atmospheric, unless otherwise noted.
 - c. Operating Temperature Range:
 - 1) Element: Minus 4 degrees F to plus 149 degrees F.
 - 2) Transmitter: Minus 4 degrees F to 113 degrees F.
3. Performance:
 - a. Range: As noted.
 - b. Zero Reference: As noted.
 - c. Accuracy: Plus or minus 0.25 percent of maximum range or 6 mm, whichever is greater.
 - d. Resolution: 0.1 percent of range or 2 mm, whichever is greater.
 - e. Blanking Distance: Sensor dependent, typically 1 foot.
4. Element:
 - a. NEMA 6P waterproof.
 - b. Housing: PVDF, unless otherwise noted.
 - 1) Other materials subject to Engineer approval.
 - c. Facing: Teflon.
 - d. Integral Flange: If noted.
 - 1) Face: PTFE, unless otherwise noted.
 - 2) Size: 8 inches.
 - e. Process Connection:
 - 1) 1-inch NPT, unless otherwise noted.
 - 2) Top mounted.
 - f. Electrically Hazardous Rating:
 - 1) Class I, Div 1, Groups A, B, C, and D: If noted.
 - 2) Class II, Div 1, Groups E, F, and G: If noted.
 - 3) Other Ratings: As noted.
 - g. Beam Angle: 12 degrees or less.
 - h. Integral temperature compensation.
5. Transmitter:
 - a. Display.
 - b. Integral keypad or nonintrusive external programming.
 - c. Enclosure: NEMA 4X polycarbonate, unless otherwise noted.
 - d. Power Supply: 115 volts, 50/60-Hz, unless otherwise noted.

- e. Isolated Analog Output:
 - 1) One Minimum: 4 mA to 20 mA dc for load impedance of 0 to 750 ohms.
- f. Digital Communication: As noted.
- g. Discrete Outputs:
 - 1) Minimum, two relay (SPDT) rated for 2 amps continuous at 230V ac.
 - 2) Assignable and as noted.
- 6. Interconnecting Cable: Weatherproof, UV protected, length as required, and type as recommended by manufacturer.
- 7. Accessories:
 - a. Submergence Shield: If noted.
 - b. Remote Programming Software: If noted.
 - 1) Allows remote programming via computer and echo traces for troubleshooting.
 - 2) One per lot of units furnished.
 - c. Others: As noted.
 - d. If no integral keypad, furnish one handheld programmer per lot of units furnished.
- 8. Manufacturers and Products:
 - a. Siemens; SITRANS L, Model HydroRanger 200 and Sensor.
 - b. Pulsar; Blackbox Series 13X and Sensor.
 - c. Endress & Hauser; Model FMU90 and Sensor.

B. L18 Level Switch, Non-Mercury:

- 1. General:
 - a. Function: Actuate contact at preset liquid level.
 - b. Type:
 - 1) Direct-acting, stainless steel float with enclosed, encapsulated switch and integral cable.
 - 2) Mercury free.
- 2. Service (Liquid): As noted.
- 3. Performance:
 - a. Setpoint: As noted.
 - b. Differential: 8 inches maximum.
 - c. Temperature: 32 degrees F (nonfreezing) to 160 degrees F.
- 4. Features:
 - a. Entire Assembly: Watertight and impact-resistant.
 - b. Float
 - 1) Material and Size: 5.5-inch diameter polymer-coated, Type 316 stainless steel float.
 - 2) Buoyancy: 2 pounds.

- c. Cable:
 - 1) Length as noted or as necessary per mounting requirements.
 - 2) Plastic-jacketed cable, oil-resistant and suitable for continuous service.
- d. Mounting:
 - 1) Anchor Mounting Kit:
 - a) 15-pound vinyl-coated cast-iron anchor.
 - b) 1/8-inch, Type 316 stainless steel wire rope.
 - c) Stainless steel cable clips.
- 5. Signal Interface:
 - a. Switch Type: Magnetic reed.
 - b. Switch Contacts:
 - 1) Isolated, rated at least 0.8 amp continuous at 120V ac.
 - 2) Contact Type: Either NO or NC, as required by application or as noted; or SPDT (NO and NC).
- 6. Accessories: As noted.
- 7. Manufacturers and Products:
 - a. Siemens Water Technologies; Model 9G-EF Direct Acting Float Switch (B100).
 - b. Contegra; Model FS90.

END OF COMPONENT SPECIFICATIONS

INSTRUMENT AND CONTROL PANEL LIST						
Tag Number	Comp Code	Component Title	Options	P&ID	Inst. Detail	Panel No.
FP-212-1	N/A	Sulfuric Acid Fill Panel	NEMA 4X 316SS Max Allowable Dimensions: 4'H x 3'W x 1'D	08-N-01	4091-402BG	
LE/LIT-212-1	L5	Level Element and Transmitter: Ultrasonic	Range: 0 - 9 FT Zero Reference: Tank Bottom	08-N-01	4091-252 4091- 383D	CHEMICAL BUILDING SCADA PANEL via FP-212-1
LSH-212-1	L18	Level Switch, Non-Mercury	Setpoint: 1 FT Above Sump Floor Above Sump Floor Rising	08-N-01	4091-248	CHEMICAL BUILDING SCADA PANEL via FP-212-1
FP-213-2	N/A	Purate Fill Panel	NEMA 4X 316SS Max Allowable Dimensions: 4'H x 3'W x 1'D	08-N-01	4091-402BG	
LE/LIT-213-2	L5	Level Element and Transmitter: Ultrasonic	Range: 0 - 9 FT Zero Reference: Tank Bottom	08-N-01	4091-252 4091-383D	CHEMICAL BUILDING SCADA PANEL via FP-213-1
LSH-213-2	L18	Level Switch, Non-Mercury	Setpoint: 1 FT Above Sump Floor Above Sump Floor Rising	08-N-01	4091-248	CHEMICAL BUILDING SCADA PANEL via FP-213-1

LOOP SPECIFICATION

Note(s):

1. This document does not describe every function required by the Contract Documents. Rather, it supplements and clarifies the functions required by the P&IDs.
2. The PIC Systems Integrator shall incorporate the new PLCs the new process equipment and functions into the existing plant PLCs and SCADA servers.

OVERVIEW

The PICS System Integrator shall program and configure the following devices:

PLC-CHEM1.

HMI graphics and SCADA server databases.

ALARMS

The PICS System Integrator shall display on the computer HMI graphics all alarms shown on the P&IDs and I/O List.

The PICS System Integrator shall also display calculated alarms such as Low Level in the each Storage Tank. The PIC System Integrator shall program the PLC to calculate these alarms.

The PIC System Integrator shall store all alarms in data registers.

STATUS MONITORING

The PICS System Integrator shall display on the computer HMI graphics all status signals shown on the P&IDs and I/O List. Examples include ON status of each Chlorine Dioxide Generation System.

The PIC System Integrator shall store all status signals in data registers.

ANALOG DISPLAYS

The PICS System Integrator shall display all analog input variables shown on the P&IDs and I/O List. Examples include storage tank levels.

The PIC System Integrator shall store these analog input variables in data registers.

TRENDS

The PIC System Integrator shall create and display trends of all analog inputs and outputs that are part of this project. This includes field analog inputs and software created analog outputs. Create and display additional trends as noted in these Loop Specifications.

DWG 08-N-01: Chlorine Dioxide Generators

The Chlorine Dioxide Generator PLC will communicate to the Chemical Building SCADA Panel via both Hardwired and Networked (Ethernet TCP/IP) connections. The vendor will provide a list of networked points that are available. Provisions will be made by the PIC System Integrator to monitor, display and trend up to 20 Analog Points and 20 Discrete Points.

The PIC System Integrator shall store the following alarms in PLC data registers, which will be accessed by the plant SCADA Servers. The PIC System Integrator shall display these alarms on the HMI computer graphics.

Fail Alarm, Chlorine Dioxide Generation System

The PIC System Integrator shall store the following status signals in PLC data registers, which will be accessed by the plant SCADA Servers. The PICS System Integrator shall display these status signals on the HMI computer graphics.

ON status, Chlorine Dioxide Generation System

The PIC System Integrator shall store the following values in PLC data registers, which will be accessed by the plant SCADA Servers. The PICS System Integrator shall display these values on the HMI computer graphics.

Production rate feedback, Chlorine Dioxide Generation System

Note: Coordinate the production rate units with the Chlorine Dioxide Generation System vendor.

From the production rate feedback values, the PLC System Integrator shall also calculate totalized production. For each Generation System, the PLC System Integrator shall calculate in the PLC four different production totalization values as described under paragraph "PRODUCTION TOTALIZATION".

The PIC System Integrator shall receive the following commands from the SCADA computers, store them in PLC data registers and forward them to the associated Chlorine Dioxide Generation System:

Run Command, Chlorine Dioxide Generation System

The above run command shall be generated from a Manual/Off/Auto display command that will be configured by the PICS System Integrator on the computer HMI graphic. Over the network, three bits will be transferred to the PLC, control action as follows:

Manual Mode: Chlorine Dioxide Generation System runs with production setpoint as described under paragraph “PRODUCTION SETPOINT CALCULATIONS”.

Off Mode: The Chlorine Dioxide Generation System does not run.

Auto Mode: Chlorine Dioxide Generation System runs with production setpoint as described under paragraph “PRODUCTION SETPOINT CALCULATIONS”, which is a flow-pacing type calculation.

For the Generation System, the PIC System Integrator shall create a Low Process Flowrate Alarm, which will be stored in the PLC register, and then forwarded to the plant SCADA servers. See Paragraph “GENERATION SYSTEM LOW PROCESS FLOWRATE ALARM”.

The PIC System Integrator shall create via the PLC the following alarms from the associated Storage Tank analog level signals.

Low Level, Purate Storage Tank

Low Level, Purate Storage Tank

Low Level, Sulfuric Acid Storage Tank

Low Level, Sulfuric Acid Storage Tank

The PIC System Integrator shall store the following alarms in PLC data registers, which will be accessed by the plant SCADA Servers. The PICS System Integrator shall display these alarms on the HMI computer graphics.

High Level, Containment Sump, Purate Storage Tank

High Level, Purate Storage Tank

High Level, Purate Storage Tank (created from analog input)

Low Level, Purate Storage Tank (created from analog input)

Low Level, Purate Storage Tank (created from analog input)

High Level, Containment Sump, Sulfuric Acid Storage Tanks

High Level, Sulfuric Acid Storage Tank

High Level, Sulfuric Acid Storage Tank (created from analog input)

Low Level, Sulfuric Acid Storage Tank (created from analog input)

Low Level, Sulfuric Acid Storage Tank (created from analog input)

The PIC System Integrator shall store the following values in PLC data registers, which will be accessed by the plant SCADA Servers. The PIC System Integrator shall display these values on the HMI computer graphics.

Level, Purate Storage Tank

Level, Sulfuric Acid Storage Tank

The PIC System Integrator shall fabricate truck delivery panels FP-212-1 and FP-213-` with functions as shown on N-02.

The PIC System Integrate shall implement the Tank Level Drop Rate Indication and Alarm Miscellaneous Control Strategy for the following:

Purate Tank, T-212-1

Sulfuric Acid Storage Tank, T-213-1

MISCELLANEOUS CONTROL STRATEGIES

Production Setpoint Calculations

The Chlorine Dioxide Generator has the capability to produce configurable ranges of output capacity. It is anticipated that 2 ranges (R_L to R_H) will be used. There will be a high range of 62 – 633 ppd and a low range of 24 – 200 ppd (configurable in the PLC with appropriate security access). Once the range of generator is set-up in the field, the operator shall select the range from the HMI computer graphic. Setting of the range shall be password protected. Once set, the range is not changed until the generator is reconfigured in the field.

When the PLC receives a bit from computer HMI graphics that Mode is Manual, the PLC System integrator shall calculate the setpoint as follows:

On the HMI computer graphic, the operator enters a production value, P . Obtain exact units from the Chlorine Dioxide Generation System vendor. As an example, a typical unit would be 100 pounds/hour. The PIC System Integrator takes this value, and converts it into a % production setpoint using the following equation:

$P\% = (P - R_L) / (R_H - R_L)$, where:

$P\%$ = % Production Setpoint

P = Production Value in Pounds/Hour (Operator Entry)

R_L = Low Range of Generator Output in Pounds/Hour

R_H = High Range of Generator Output in Pounds/ Hour

This % Production Setpoint, $P\%$, is then sent to the Generation System panel.

When the PLC receives a bit from computer HMI graphics that Mode is Auto, the PLC System integrator shall calculate the setpoint as follows:

On the HMI computer graphic, the operator enters a dosage value in units of mg/l (confirm these units with the Chlorine Dioxide Generation System vendor). As an example, a typical dosage unit would be 1 mg/liter. The PIC System Integrator takes this value, and converts into a % production setpoint using the following equation:

Step 1: Convert Dosage to Production Value:

$P = [(D / 453592.37) / 0.26] \times F_{IN} \times 1,000,000$, where:

P = Production Value in Pounds/Hour

D = Dosage in mg/liter (Operator Entry)

F_{IN} = Plant Influent Flow in MGD

Step 2: Calculate % Production Setpoint:

$P\% = (P - R_L) / (R_H - R_L)$, where:

P% = % Production Setpoint

P = Production Value in Pounds/Hour (Operator Entry)

R_L = Low Range of Generator Output in Pounds/Hour

R_H = High Range of Generator Output in Pounds/Hour

This % Production Setpoint, P%, is then sent to the Generation System panel.

Production Totalization

Within the PLC, the PIC System Integrator shall totalize chlorine dioxide production of each generation system as follows:

Today's totalized production.

Yesterday's totalized production.

This Month's totalized production.

Last Month's totalized production.

These values shall be stored by the PIC System Integrator in a PLC data register and then forwarded to the plant SCADA servers.

The PICS System Integrator shall configure the HMI computer graphics to display each of these totalized productions.

Generation System Low Process Flowrate Alarm

The PIC System Integrator shall configure the PLC to monitor the process flowrate associated with the chlorine dioxide generation system. Coordinate with Owner/Engineer. Typically, the process flowrate is the applicable raw water flowrate.

If process flowrate is low for a sustained time; initial setpoint, 1 minute AND the PLC is receiving the run command signal, the PIC System Integrator shall create an alarm signal and store it in the PLC data register.

The PICS System Integrator shall configure Alarm displays and display on the HMI computer graphics. Typical message is” “Chlorine Dioxide Generation System, Low Process Flowrate.

Tank Level Drop Rate Indication and Alarm

Purpose of this function is to alarm a potential leak in the tank/piping delivery system.

Create a tank level drop rate variable. Units are in inches of tank level / hour. Calculate this variable continuously, even though time units are in hours.

Time smooth this variable.

Display the time-smoothed tank level drop rate on the HMI.

Create an alarm setpoint, with initial setpoint of 3 inches/hours.

Display the alarm setpoint, and make it adjustable from the HMI.

If the time-smoothed tank level drop rate exceeds the alarm setpoint, display an alarm on the HMI.

Trend the time-smoothed tank level drop rate.

Preventing Nuisance Alarms

To prevent nuisance alarms, the PLC System Integrator shall provide PLC software time delays to alarm and control strategies during non-steady state conditions such as startup, loss of power and transitions.

END OF LOOP DESCRIPTIONS

PLC INPUT/OUTPUT LISTS

PLC	Dwg	Tag No.	Function/Description	DI	DO	AI	AO	Remarks
CHEM SCADA	08-N-01	LAH-212-9	HIGH LEVEL, SULFURIC ACID CONTAINMENT SUMP	1				
CHEM SCADA	08-N-01	LI-212-1	LEVEL INDICATION, SULFURIC ACID STORAGE TANK			1		
CHEM SCADA	08-N-01	LAHH-212-1	HIGH LEVEL, SULFURIC ACID STORAGE TANK	1				
CHEM SCADA	08-N-01	M-210-1 ~PROD SP	PRODUCTION SETPOINT, CHLORINE DIOXIDE GENERATOR M-210-1				1	
CHEM SCADA	08-N-01	M-210-1 ~RK	REMOTE START, CHLORINE DIOXIDE GENERATOR M-210-1		1			
CHEM SCADA	08-N-01	M-210-1 ~EN	RUN PERMISSIVE, CHLORINE DIOXIDE GENERATOR M-210-1		1			
CHEM SCADA	08-N-01	M-210-1 ~YS	ON STATUS, CHLORINE DIOXIDE GENERATOR M-210-1	1				
CHEM SCADA	08-N-01	M-210-1 ~FA1	GENERAL ALARM, CHLORINE DIOXIDE GENERATOR M-210-1	1				
CHEM SCADA	08-N-01	M-210-1 ~FA2	SHUTDOWN ALARM, CHLORINE DIOXIDE GENERATOR M-210-1	1				
CHEM SCADA	08-N-01	M-211-2 ~YS	ON STATUS, BOOSTER PUMP P-211-2	1				
CHEM SCADA	08-N-01	M-210-1 ~PROD	PRODUCTION CHLORINE DIOXIDE GENERATOR M-210-1			1		
CHEM SCADA	08-N-01	LAH-213-9	HIGH LEVEL, PURATE CONTAINMENT SUMP	1				
CHEM SCADA	08-N-01	LI-213-1	LEVEL INDICATION, PURATE STORAGE TANK			1		
CHEM SCADA	08-N-01	LAHH-213-1	HIGH HIGH LEVEL, PURATE STORAGE TANK	1				
CHEM SCADA	08-N-01	FAH-200-1	SAFETY SHOWER ACTIVATED	1				
			CHEM SCADA TOTALS	6	1	3	1	

CH2M HILL INSTRUMENT CALIBRATION SHEET

Rev.06.05.92

COMPONENT				MANUFACTURER				PROJECT			
Code:				Name:				Number:			
Name:				Model:				Name:			
				Serial #:							
FUNCTIONS											
Indicate? Y / N		RANGE	VALUE	UNITS	COMPUTING FUNCTIONS? Y / N			CONTROL? Y / N			
		Chart:			Describe:			Action? direct / reverse Modes? P / I / D			
Record? Y / N		Scale:						SWITCH? Y / N			
Transmit/ Convert? Y / N		Input:						Unit Range: Differential: Reset? automatic / manual			
		Output:						fixed/adjustable			
ANALOG CALIBRATIONS						DISCRETE CALIBRATIONS					
REQUIRED			AS CALIBRATED			REQUIRED			AS CALIBRATED		
Input	Indicated	Output	Increasing Indicated	Input Output	Decreasing Indicated	Input Output	Reset Pt.	Trip Point (note rising or falling)	Reset Pt.	Trip Point (note rising or falling)	Reset Pt.
CONTROL MODE SETTINGS:						P:	I:	D:			
#	NOTES:										
Component Calibrated and Ready for Startup											
By:											
Date:											
Tag No.:											

CH2M HILL
INSTRUMENT CALIBRATION SHEET
EXAMPLE - ANALYZER/TRANSMITTER

Rev.06.05.92

COMPONENT				MANUFACTURER		PROJECT	
Code: <i>A7</i>				Name: <i>Leeds & Northrup</i>		Number: <i>WDC30715.B2</i>	
Name: <i>pH Element & Analyzer/Transmitter</i>				Model: <i>12429-3-2-1-7</i>		Name: <i>UOSA AWT PHASE 3</i>	
				Serial #: <i>11533322</i>			
FUNCTIONS							
		RANGE	VALUE	UNITS	COMPUTING FUNCTIONS? N		CONTROL? N
Indicate? Y Record? N		Chart:			Describe:		Action? direct / reverse Modes? P / I / D
		Scale:	<i>1-14</i>	<i>pH units</i>			SWITCH? N
Transmit/ Convert? Y		Input:	<i>1-14</i>	<i>pH units</i>			Unit Range:
		Output:	<i>4-20</i>	<i>mA dc</i>			Differential: fixed/adjustable
							Reset? automatic / manual
ANALOG CALIBRATIONS				DISCRETE CALIBRATIONS			
REQUIRED		AS CALIBRATED			REQUIRED		AS CALIBRATED
Input	Indicated	Output	Increasing Input Indicated	Decreasing Input Output	Number	Trip Point	Reset Pt.
<i>1.0</i>	<i>1.0</i>	<i>4.0</i>	<i>1.0</i>	<i>3.9</i>			
<i>2.3</i>	<i>2.3</i>	<i>5.6</i>	<i>2.2</i>	<i>5.6</i>	1.	<i>N.A.</i>	(note rising or falling)
<i>7.5</i>	<i>7.5</i>	<i>12.0</i>	<i>7.5</i>	<i>12.0</i>	2.		<i>N.A.</i>
<i>12.7</i>	<i>12.7</i>	<i>18.4</i>	<i>12.7</i>	<i>18.3</i>	3.		
<i>14.0</i>	<i>14.0</i>	<i>20.0</i>	<i>14.0</i>	<i>20.0</i>	4.		
					5.		
					6.		
					7.		
CONTROL MODE SETTINGS:				P: <i>N.A.</i>	I:	D:	
#	NOTES:						
	<i>1. Need to recheck low pH calibration solutions.</i>						
	Component Calibrated and Ready for Startup						
	By: <i>J.D. Sewell</i>						
	Date: <i>Jun-6-92</i>						
	Tag No.: <i>AIT-12-6[pH]</i>						

CH2M HILL

I&C VALVE ADJUSTMENT SHEET

Rev.06.05.92

PARTS	Project Name:		Project Number:		
Body	Type:		Mfr:		
	Size:		Model:		
	Line Connection:		Serial #:		
Operator	Type:		Mfr:		
	Action:		Model:		
	Travel:		Serial #:		
Positioner	Input Signal:		Mfr:		
	Action:		Model:		
	Cam:		Serial #:		
Pilot Solenoid	Action:		Mfr:		
	Rating:		Model:		
			Serial #:		
I/P Converter	Input:		Mfr:		
	Output:		Model:		
	Action:		Serial #:		
Position Switch	Settings:		Mfr:		
	Contacts:		Model:		
			Serial #:		
Power Supply	Type:		Air Set Mfr:		
	Potential:		Model:		
			Serial #:		
ADJUSTMENTS	Initial	Date	VERIFICATION	Initial	Date
Air Set			Valve Action		
Positioner			Installation		
Position Switches			Wire Connection		
I/P Converter			Tube Connection		
Actual Speed					
REMARKS:			Valve Ready for Startup		
			By:		
			Date:		
			Tag No.:		

CH2M HILL

I&C VALVE ADJUSTMENT SHEET

Rev.06.05.92

EXAMPLE

PARTS	Project Name: <i>SFO SEWPCP</i>	Project Number: <i>SFO10145.G2</i>			
Body	Type: <i>Vee-Ball</i>	Mfr: <i>Fisher Controls</i>			
	Size: <i>4-inch</i>	Model: <i>1049763-2</i>			
	Line Connection: <i>159 # ANSI Flanges</i>	Serial #: <i>1003220</i>			
Operator	Type: <i>Pneumatic Diaphragm</i>	Mfr: <i>Fisher Controls</i>			
	Action: <i>Linear - Modulated</i>	Model: <i>4060D</i>			
	Travel: <i>3-inch</i>	Serial #: <i>2007330</i>			
Positioner	Input Signal: <i>3-15 psi</i>	Mfr: <i>Fisher Controls</i>			
	Action: <i>Direct - air to open</i>	Model: <i>20472T</i>			
	Cam: <i>Equal percentage</i>	Serial #: <i>102010</i>			
Pilot Solenoid	Action:	Mfr:			
	Rating: <i>None</i>	Model:			
		Serial #:			
I/P Converter	Input: <i>4-20 mA dc</i>	Mfr: <i>Taylor</i>			
	Output: <i>3-15 psi</i>	Model: <i>10-T-576-3</i>			
	Action: <i>Direct</i>	Serial #: <i>1057-330</i>			
Position Switch	Settings: <i>Closed / Open 5 deg, rising</i>	Mfr: <i>National Switch</i>			
	Contacts: <i>Close / Close</i>	Model: <i>1049-67-3</i>			
		Serial #: <i>156 & 157</i>			
Power Supply	Type: <i>Pneumatic</i>	Air Set Mfr: <i>Air Products</i>			
	Potential: <i>40 psi</i>	Model: <i>3210D</i>			
		Serial #: <i>1107063</i>			
ADJUSTMENTS	Initial	Date	VERIFICATION	Initial	Date
Air Set	<i>JDS</i>	<i>Jun-06-92</i>	Valve Action	<i>JDS</i>	<i>Jun-03-92</i>
Positioner	<i>JDS</i>	<i>Jun-06-92</i>	Installation	<i>JDS</i>	<i>Jun-03-92</i>
Position Switches	<i>JDS</i>	<i>Jun-06-92</i>	Wire Connection	<i>JDS</i>	<i>Jun-04-92</i>
I/P Converter	<i>JDS</i>	<i>Jun-07-92</i>	Tube Connection	<i>JDS</i>	<i>Jun-04-92</i>
Actual Speed	<i>JDS</i>	<i>Jun-07-92</i>			
REMARKS: <i>Valve was initially installed backwards.</i> <i>Observed to be correctly installed May-25-92</i>				Valve Ready for Startup	
				By: <i>J.D. Sewell</i>	
				Date: <i>Jun-07-92</i>	
				Tag No.: <i>FCV-10-2-1</i>	

[illegible]

CH2M HILL PERFORMANCE ACCEPTANCE TEST SHEET
EXAMPLE

Rev.06.05.92

Project Name: <i>SFO SEWPCP Plant Expansion</i>		Project No.: <i>SFO12345.C1</i>																										
Demonstration Test(s): For each functional requirement of the loop: (a) List and number the requirement. (b) Briefly describe the demonstration test. (c) Cite the results that will verify the required performance. (d) Provide space for signoff.																												
1. MEASURE EFFLUENT FLOW																												
1.a With no flow, water level over weir should be zero and																												
FIT indicator should read zero.			Jun-20-92 BDG																									
2. FLOW INDICATION AND TRANSMISSION TO LP & CCS																												
With flow, water level and FIT indicator should be related by expression																												
$Q(\text{MGD}) = 429 * H^{2/3}$ (H = height in inches of water over weir).																												
Vary H and observe that following.																												
2.a Reading of FIT indicator.			Jun-6-92 BDG																									
2.b Reading is transmitted to FI on LP-521-1.			Jun-6-92 BDG																									
2.c Reading is transmitted and displayed to CCS.			Jun-6-92 BDG																									
<table style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 20%;">H(measured)</td> <td style="width: 10%;">0</td> <td style="width: 10%;">5</td> <td style="width: 10%;">10</td> <td style="width: 10%;">15</td> </tr> <tr> <td>Q(computed)</td> <td>0</td> <td>47.96</td> <td>135.7</td> <td>251.7</td> </tr> <tr> <td>Q(FIT indicator)</td> <td>0</td> <td>48.1</td> <td>137</td> <td>253</td> </tr> <tr> <td>Q(LI on LP-521-1)</td> <td>0</td> <td>48.2</td> <td>138</td> <td>254</td> </tr> <tr> <td>Q(display by CCS)</td> <td>0</td> <td>48.1</td> <td>136.2</td> <td>252.4</td> </tr> </table>				H(measured)	0	5	10	15	Q(computed)	0	47.96	135.7	251.7	Q(FIT indicator)	0	48.1	137	253	Q(LI on LP-521-1)	0	48.2	138	254	Q(display by CCS)	0	48.1	136.2	252.4
H(measured)	0	5	10	15																								
Q(computed)	0	47.96	135.7	251.7																								
Q(FIT indicator)	0	48.1	137	253																								
Q(LI on LP-521-1)	0	48.2	138	254																								
Q(display by CCS)	0	48.1	136.2	252.4																								
Forms/Sheets Verified	By	Date	Loop Accepted By Owner																									
Loop Status Report	J.D. Sewell	May-18-92	By: J.D. Smith																									
Instrument Calibration Sheet	J.D. Sewell	May-18-92	Date: Jun-6-92																									
I&C Valve Calibration Sheet	N.A.		Loop No.: 30-12																									
Performance Acceptance Test	By	Date																										
Performed	J. Blow MPSDC Co.	Jun-6-92																										
Witnessed	B.deGlanville	Jun-6-92																										

SECTION 40 99 90
PACKAGE CONTROL SYSTEMS

PART 1 GENERAL

1.01 REFERENCES

- A. The following is a list of standards which may be referenced in this section:
1. Instrumentation, Systems, Automation Society (ISA): S50.1, Compatibility of Analog Signals for Electronic Process Instruments.
 2. National Electrical Manufacturers Association (NEMA):
 - a. 250, Enclosures for Electrical Equipment (1,000 Volts Maximum).
 - b. AB 1, Molded Case Circuit Breakers and Molded Case Switches.
 - c. ICS 2, Industrial Control Devices, Controllers and Assemblies.
 3. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC).
 4. Underwriters Laboratories Inc. (UL): 508A, Standards for Safety, Industrial Control Panels.

1.02 SYSTEM DESCRIPTION

- A. Assemble panels and install instruments, plumbing, and wiring in equipment manufacturer's factories.
- B. Test panels and panel assemblies for proper operation prior to shipment from equipment manufacturer's factory.

1.03 SUBMITTALS

- A. Action Submittals:
1. Bill of material, catalog information, descriptive literature, wiring diagrams, and Shop Drawings for components of control system.
 2. Catalog information on electrical devices furnished with system.
 3. Shop Drawings, catalog material, and dimensional layout drawings for control panels and enclosures.
 4. Panel elementary diagrams of prewired panels. Include in diagrams control devices and auxiliary devices, for example, relays, alarms, fuses, lights, fans, and heaters.
 5. Plumbing diagrams of preplumbed panels and interconnecting plumbing diagrams.
 6. Interconnection wiring diagrams that include numbered terminal designations showing external interfaces.

B. Informational Submittals:

1. Programmable Controller Submittals:
 - a. Complete set of user manuals.
 - b. Fully documented ladder logic listings.
 - c. Function listing for function blocks not fully documented by ladder logic listings.
 - d. Cross-reference listing.
2. Manufacturer's list of proposed spares, expendables, and test equipment.
3. Manufacturer's Certificate of Proper Installation in accordance with Section 01 43 33, Manufacturers' Field Services.

1.04 DELIVERY, STORAGE, AND HANDLING

- A. Prior to shipment, include corrosive-inhibitive vapor capsules in shipping containers and related equipment as recommended by capsule manufacturer.

1.05 EXTRA MATERIALS

- A. Spares, Expendables, and Test Equipment:
1. Selector Switch, Pushbutton, and Indicating Light: 20 percent, one minimum, of each type used.
 2. Light Bulb: 100 percent, 2 minimum, of each type used.
 3. Fuse: 100 percent, 5 minimum, of each type used.
 4. Surge Suppressors: 20 percent, one minimum, of each type used.

PART 2 PRODUCTS

2.01 GENERAL

- A. Section 40 90 01, Instrumentation and Control for Process Systems.

2.02 SIGNAL CHARACTERISTICS

- A. As defined in Section 40 90 01, Instrumentation and Control for Process Systems.

2.03 CORROSION PROTECTION

- A. Corrosion-Inhibiting Vapor Capsule Manufacturers:
1. Northern Instruments; Model Zerust VC.
 2. Hoffmann Engineering; Model A-HCI.

2.04 CONTROL PANEL

- A. Panel Construction and Interior Wiring: In accordance with the National Electrical Code (NEC), UL 508, state and local codes, and applicable sections of NEMA, ANSI, and ICECA.
- B. Conform to NEMA ratings as specified in individual equipment sections.
- C. Minimum Metal Thickness: 14-gauge.
- D. NEMA 250, Type 4X Panels: Type 316 stainless steel construction unless otherwise specified.
- E. Doors:
 - 1. Three-point latching mechanisms in accordance with NEMA 250 Type 1 and 12 panels with doors higher than 18 inches.
 - 2. For other doors, stainless steel quick release clamps.
- F. Cutouts shall be cut, punched, or drilled and finished smoothly with rounded edges.
- G. Access: Front, suitable for installation with back and sides adjacent to or in contact with other surfaces, unless otherwise specified.
- H. Temperature Control:
 - 1. Size panels to adequately dissipate heat generated by equipment mounted on or in the panel.
 - 2. Furnish cooling fans with air filters if required to dissipate heat.
 - 3. For panels outdoors or in unheated areas, furnish thermostatically controlled heaters to maintain temperature above 40 degrees F.
- I. Push-to-Test Circuitry: For each push-to-test indicating light, provide a fused push-to-test circuit.
- J. Lighting: Minimum of one hand switch controlled internal 100-watt incandescent light for panels 12 cubic feet and larger.
- K. Minimum of one 120-volt GFCI duplex receptacle for panels 12 cubic feet and larger.
- L. Finish:
 - 1. Metallic External Surfaces (Excluding Aluminum and Stainless Steel): Manufacturer's standard gray unless otherwise specified.
 - 2. Internal Surfaces: White enamel.

M. Panel Manufacturers:

1. Hoffman.
2. H.F. Cox.

N. Breather and Drains: Furnish with NEMA 250, Type 4 and 4X panels.

1. Manufacturer and Product: Cooper Crouse-Hinds; ECD Type 4X Drain and Breather; Drain Model ECD1-N4D, Breather Model ECD1-N4B.

2.05 CONTROL PANEL ELECTRICAL

A. UL Listing Mark for Enclosures: Mark stating "Listed Enclosed Industrial Control Panel" per UL 508A.

B. I&C and electrical components, terminals, wires, and enclosures UL recognized or UL listed.

C. Control Panels without Motor Starters:

1. Furnish main circuit breaker and a circuit breaker on each individual branch circuit distributed from power panel.
2. Locate to provide clear view of and access to breakers when door is open. Group on single subpanel. Provide typed directory.
3. Circuit Breakers:
 - a. Coordinate for fault in branch circuit trips, branch breaker, and not main breaker.
 - b. Branch Circuit Breakers: 15 amps at 250V ac.
 - c. Breaker Manufacturers and Products:
 - 1) Heineman Electric Co.; Series AM.
 - 2) Airpax/North American Philips Controls Corp.; Series 205.

D. Wiring:

1. ac Circuits:
 - a. Type: 600-volt, Type MTW stranded copper.
 - b. Size: For current to be carried, but not less than 14 AWG.
2. Analog Signal Circuits:
 - a. Type: 300-volt, Type 2 stranded copper, twisted shielded pairs.
 - b. Size: 18 AWG, minimum.
3. Other dc Circuits.
 - a. Type: 600-volt, Type MTW stranded copper.
 - b. Size: 18 AWG, minimum.
4. Separate analog and other dc circuits at least 6 inches from any ac power and control wiring.
5. Enclose wiring in sheet metal raceways or plastic wiring ducts.

6. Wire Identification: Numbered and tagged at each termination.
 - a. Wire Tags: Machine printed, heat shrink.
 - b. Manufacturers:
 - 1) Brady PermaSleeve.
 - 2) Tyco Electronics.
- E. Wiring Interface:
 1. For analog and discrete signal, terminate at numbered terminal blocks.
 2. For special signals, terminate power (240 volts or greater) at manufacturer's standard connectors.
 3. For panel, terminate at equipment on/with which it is mounted.
- F. Terminal Blocks:
 1. Quantity:
 - a. For external connections.
 - b. Wire spare or unused panel mounted elements to their panels' terminal blocks.
 - c. Spare Terminals: 20 percent of connected terminals, but not less than 10.
 2. General: Group to keep 120V ac circuits separate from 24V dc circuits.
 - a. Connection Type: Screw connection clamp.
 - b. Compression Clamp:
 - 1) Hardened steel clamp with transversal grooves penetrating wire strands providing a vibration-proof connection.
 - 2) Guides strands of wire into terminal.
 - c. Screws: Hardened steel, captive, and self-locking.
 - d. Current Bar: Copper or treated brass.
 - e. Insulation:
 - 1) Thermoplastic rated for minus 55 to plus 110 degrees C.
 - 2) Two funnel shaped inputs to facilitate wire entry.
 - f. Mounting:
 - 1) Rail.
 - 2) Terminal block can be extracted from an assembly without displacing adjacent blocks.
 - 3) End Stops: One at each end of rail, minimum.
 - g. Wire Preparation: Stripping only.
 - h. Jumpers: Allow jumper installation without loss of space on terminal or rail.
 - i. Marking System:
 - 1) Terminal number shown on both sides of terminal block.
 - 2) Allow use of preprinted and field marked tags.
 - 3) Terminal strip numbers shown on end stops.
 - 4) Mark terminal block and terminal strip numbers as shown.
 3. Terminal Block, 120-Volt Power:
 - a. Rated Voltage: 600V ac.
 - b. Rated Current: 30 amp.

- c. Wire Size: 22 through 10 AWG.
- d. Rated Wire Size: 10 AWG.
- e. Color: Gray body.
- f. Spacing: 0.25 inch, maximum.
- g. Manufacturer and Product: Entrelec; Type M4/6.
- 4. Terminal Block, Ground:
 - a. Wire Size: 22 through 12 AWG.
 - b. Rated Wire Size: 12 AWG.
 - c. Color: Green and yellow body.
 - d. Spacing: 0.25 inch, maximum.
 - e. Grounding: Ground terminal blocks electrically grounded to the mounting rail.
 - f. Manufacturer and Product: Entrelec; Type M4/6.P.
- 5. Terminal Block, Blade Disconnect Switch:
 - a. Use: Provide one for each discrete input and output field interface wire.
 - b. Rated Voltage: 600V ac.
 - c. Rated Current: 10 amp.
 - d. Wire Size: 22 through 12 AWG.
 - e. Rated Wire Size: 12 AWG.
 - f. Color: Gray body, orange switch.
 - g. Spacing: 0.25 inch, maximum.
 - h. Manufacturer and Product: Entrelec; Type M4/6.SN.
- 6. Terminal Block, Fused, 24V dc:
 - a. Rated Voltage: 600V dc.
 - b. Rated Current: 6.3 amp.
 - c. Wire Size: 22 through 12 AWG.
 - d. Rated Wire Size: 12 AWG.
 - e. Color: Gray body.
 - f. Fuse: 5 by 20 GMA fuses.
 - g. Fuse Marking: Fuse amperage rating shown on top of terminal block.
 - h. Indication: LED diode 24V dc.
 - i. Leakage Current: 5.2 mA, maximum.
 - j. Spacing: 0.32 inch, maximum.
 - k. Manufacturer and Product: Entrelec; Type M4/6.SFD.
- 7. Terminal Block, Fused, 120V ac:
 - a. Rated Voltage: 600V ac.
 - b. Rated Current: 6.3 amp.
 - c. Wire Size: 22 through 12 AWG
 - d. Rated Wire Size: 12 AWG.
 - e. Color: Gray body.
 - f. Fuse: 5 by 20 GMA fuses.
 - g. Fuse Marking: Fuse amperage rating shown on top of terminal block.
 - h. Indication: Neon lamp 110V ac.

- i. Leakage Current: 1.8 mA, maximum.
 - j. Spacing: 0.32 inch, maximum
 - k. Manufacturer and Product: Entrelec; Type M4/6.SFL.
- G. Grounding: Internal copper grounding bus for ground connections on panels, consoles, racks, and cabinets.
- H. Relays:
 - 1. General:
 - a. Relay Mounting: Plug-in type socket.
 - b. Relay Enclosure: Provide dust cover.
 - c. Socket Type: Screw terminal interface with wiring.
 - d. Socket Mounting: Rail.
 - e. Furnish holddown clips.
 - 2. Control Circuit Switching Relay, Nonlatching:
 - a. Type: Compact general purpose plug-in.
 - b. Contact Arrangement: 3 Form C contacts.
 - c. Contact Rating: 10A at 28V dc or 240V ac.
 - d. Contact Material: Silver cadmium oxide alloy.
 - e. Coil Voltage: As noted or shown.
 - f. Coil Power: 1.8 watts (dc), 2.7VA (ac).
 - g. Expected Mechanical Life: 10,000,000 operations.
 - h. Expected Electrical Life at Rated Load: 100,000 operations.
 - i. Indication Type: Neon or LED indicator lamp.
 - j. Push-to-test button.
 - k. Manufacturer and Product: Potter and Brumfield; Series KUP.
 - 3. Control Circuit Switching Relay, Latching:
 - a. Type: Dual coil mechanical latching relay.
 - b. Contact Arrangement: 2 Form C contacts.
 - c. Contact Rating: 10A at 28V dc or 120V ac.
 - d. Contact Material: Silver cadmium oxide alloy.
 - e. Coil Voltage: As noted or shown.
 - f. Coil Power: 2.7 watts (dc), 5.3VA (ac).
 - g. Expected Mechanical Life: 500,000 operations.
 - h. Expected Electrical Life at Rated Load: 50,000 operations.
 - i. Manufacturer and Product: Potter and Brumfield; Series KB/KBP.
 - 4. Control Circuit Switching Relay, Time Delay:
 - a. Type: Adjustable time delay relay.
 - b. Contact Arrangement: 2 Form C contacts.
 - c. Contact Rating: 10A at 240V ac.
 - d. Contact Material: Silver cadmium oxide alloy.
 - e. Coil Voltage: As specified or shown.
 - f. Operating Temperature: Minus 10 to 55 degrees C.
 - g. Repeatability: Plus or minus 2 percent.

- h. Delay Time Range: Select range such that time delay set point fall between 20 to 80 percent or range.
- i. Time Delay Set Point: As specified or shown.
- j. Mode of Operation: As specified or shown.
- k. Adjustment Type: Integral potentiometer with knob external to dust cover.
- l. Manufacturer and Products: Potter and Brumfield.
 - 1) Series CB for 0.1-second to 100-minute delay time ranges.
 - 2) Series CK for 0.1- to 120-second delay time ranges.

I. Intrinsic Safety Barriers:

- 1. Intrinsically Safe Relays: Monitor discrete signals that originate in hazardous area and are used in a safe area.
 - a. Manufacturer and Product: MTL, Inc.; Series MTL 5000.
- 2. Intrinsically Safe Barriers: Interface analog signals as they pass from hazardous area to safe area.
 - a. Manufacturer and Product: MTL, Inc.; Series MTL 5000.

J. Programmable Controllers:

- 1. Solid state units capable of performing same function as conventional relays, timers, counters, drum sequencers, arithmetic, and other special functions necessary to perform required control functions.
- 2. Ethernet TCP/IP Communication Capability.
- 3. Minimum of 64 internal control relays, 16 timer/counters, and four, 16 stop drum sequencers. Furnish minimum of 256 words of nonvolatile memory.
- 4. Minimum of 12 discrete inputs and 8 discrete outputs, optical isolations rated at 2,500-volt rms. Discrete inputs shall be 120V ac. Discrete outputs shall be rated for 2 amps at 120V ac. Each input and output shall have an LED ON/OFF status indicator.
- 5. Minimum of 25 percent excess capacity for inputs, outputs, internal coils, registers, and other necessary functions.
- 6. Capable of operating in a hostile industrial environment (for example, heat, electrical transients, RFI, and vibration) without fans, air conditioning, or electrical filtering. Units operate from 0 to 60 degrees C and up to 95 percent humidity, noncondensing.
- 7. Furnish with a handheld, CRT, or personal computer programmer that plugs into controller. Program using conventional relay ladder diagram notation and drum sequencer chart notation. Programmer shall provide a force function to set inputs or outputs to a given state regardless of program or input conditions. Programmer shall indicate power flow through internal elements.

K. Front-of-Panel Devices in Conjunction with NEMA 250, Type 1 and 12 Panels:

1. Potentiometer Units:
 - a. Three-terminal, oiltight construction, resolution of 1 percent and linearity of plus or minus 5 percent.
 - b. Single-hole, panel mounting accommodating panel thicknesses between 1/8 and 1/4 inch.
 - c. Include legend plates with service markings.
 - d. Manufacturers and Products:
 - 1) Allen-Bradley; Model 800T.
 - 2) Eaton/Cutler-Hammer; Model 10250T.
2. Indicating Lights:
 - a. Heavy-duty, push-to-test type, oiltight, industrial type with integral transformer for 120V ac applications.
 - b. Screwed on prismatic glass lenses in colors noted and factory engraved legend plates for service legend.
 - c. Manufacturers and Products:
 - 1) Eaton/Cutler-Hammer; Type 10250T.
 - 2) General Electric; CR2940U.
3. Pushbutton, Momentary:
 - a. Heavy-duty, oiltight, industrial type with full guard and momentary contacts rated for 10 amperes continuous at 120V ac.
 - b. Standard size legend plates with black field and white markings for service legend.
 - c. Manufacturers and Products:
 - 1) Square D; Class 9001, Type K.
 - 2) Eaton/Cutler-Hammer; Type T.
 - 3) General Electric; Type CR-2940.
4. Selector Switch:
 - a. Heavy-duty, oiltight, industrial type with contacts rated for 120V ac service at 10 amperes continuous.
 - b. Standard size, black field, legend plates with white markings, for service legend.
 - c. Operators: Black knob type.
 - d. Single-hole mounting, accommodating panel thicknesses from 1/16 inch to 1/4 inch.
 - e. Manufacturers and Products for Units with up to Four Selection Positions:
 - 1) Eaton/Cutler-Hammer; Type T.
 - 2) Square D; Type K.
 - f. Manufacturers and Products for Units with up to 12 Selection Positions:
 - 1) Rundel-Idec; Standard Cam Switch.
 - 2) Electroswitch; 31.

L. Front-of-Panel Devices Used in Conjunction with NEMA 250, Type 4X Panels:

1. Potentiometer, Watertight:
 - a. Three-terminal, heavy-duty NEMA 250, Type 4X watertight construction, resolution of 1 percent and linearity of plus or minus 5 percent.
 - b. Single-hole, panel mounting accommodating panel thicknesses between 1/8 and 1/4 inch.
 - c. Include engraved legend plates with service markings.
 - d. Manufacturer and Product: Allen-Bradley; Bulletin 800H.
2. Indicating Lights, Watertight:
 - a. Heavy-duty, push-to-test type, NEMA 250, Type 4X watertight, industrial type with integral transformer for 120V ac applications and corrosion-resistant service.
 - b. Screwed on prismatic lenses and factory engraved legend plates for service legend.
 - c. Manufacturers and Products:
 - 1) Square D; Type SK.
 - 2) Allen-Bradley; Type 800H.
3. Pushbutton, Momentary, Watertight:
 - a. Heavy-duty, NEMA 250, Type 4X watertight, industrial type with momentary contacts rated for 120V ac service at 10 amperes continuous and corrosion-resistant service.
 - b. Standard size, black field, legend plates with white markings for service legend.
 - c. Manufacturers and Products:
 - 1) Square D; Type SK.
 - 2) Allen-Bradley; Type 800H.
4. Selector Switch, Watertight:
 - a. Heavy-duty, NEMA 250, Type 4X watertight, industrial type with contacts rated for 120V ac service at 10 amperes continuous and corrosion-resistant service.
 - b. Standard size, black field, legend plates with white markings, for service legend.
 - c. Operators: Black knob type.
 - d. Single-hole mounting, accommodating panel thicknesses from 1/16 to 1/4 inch.
 - e. Manufacturer and Products:
 - 1) Square D; Class 9001, Type SK.
 - 2) Allen-Bradley; Type 800H.

2.06 HARDWARE DOCUMENTATION

A. Provide the following for all elements of the PLC:

1. Block Diagram: A diagram showing all major system components. Identify components by manufacturer and model number. Show interconnecting cables diagrammatically.
2. Bill-of-Materials: A list of all PLC components. Group components by type and include:
 - a. Component manufacturer, model number and part number.
 - b. Component description.
 - c. Quantity supplied.
 - d. Reference to component catalog information.
3. Descriptive Information: Catalog information, descriptive literature, performance specifications, internal wiring diagrams, power and grounding requirements, power consumption, and heat dissipation of all elements of the PLC system. Clearly mark all options and features proposed for this Project.
4. Interconnecting Wiring Diagrams: Diagrams shall show all PLC elements, their interconnecting cables and wiring terminations, and all terminations to all interacting elements and subsystems. Terminations shall be numbered. Terminations for circuits extending outside PLC assemblies and/or leaving panels shall be labeled with circuit names corresponding to the Circuit and Raceway Schedule. The external circuit portion of this diagram shall be coordinated with the Electrical Subcontractor and shall bear his mark showing that this work has been done.
5. Outline Drawings: Equipment envelope drawings showing: External dimensions, enclosure materials, conduit connections and installation requirements.
6. Installation Details: Any modifications or further details as may be required to supplement the Contact Documents and adequately define the installation of the PLC elements.
7. Input/Output List: For each I/O point, list point type, tag number of the source or final control element, equipment description, PLC number, PLC terminal identification, rack number, module slot number and PLC address.
8. Provide documentation on the type of Operator Interface being used.

2.07 INSTRUMENT TAG NUMBERS

A. Tag numbers shall match those shown on P&IDs.

2.08 NAMEPLATES, NAMETAGS, AND SERVICE LEGENDS

- A. Nametags: Permanently mounted bearing entire ISA tag number.
1. Panel Mounted: Plastic, mounted to instrument behind panel face.
 2. Field Mounted: Engraved Type 316 stainless steel, 22-gauge minimum thickness, attached with stainless steel.
- B. Service Legends (Integrally Mounted with Instrument) and Nameplates:
1. Engraved, rigid, laminated plastic type with adhesive back. Furnish service legends and nameplates to adequately describe functions of panel face mounted instruments.
 2. Color: White with black letters.
 3. Letter Height: 3/16 inch.
 4. For each panel, face mounted laminated nameplate inscribed with the panel name and tag number. Color shall be white with black letters 1/2-inch high.
- C. Standard Light Colors and Inscriptions: Unless otherwise specified in individual equipment specifications, use the following color code and inscriptions:

Tag	Inscription(s)	Color
ON	ON	Red
OFF	OFF	Green
OPEN	OPEN	Red
CLOSED	CLOSED	Green
LOW	LOW	Amber
FAIL	FAIL	Amber
HIGH	HIGH	Amber
AUTO	AUTO	White
MANUAL	MANUAL	Yellow
LOCAL	LOCAL	White
REMOTE	REMOTE	Yellow
FORWARD	FORWARD	Red
REVERSE	REVERSE	Blue

D. Standard Pushbutton Colors and Inscriptions:

1. Use following unless otherwise noted in:

Tag Function	Inscription(s)	Color
OO	ON OFF	Red Green
OC	OPEN CLOSE	Red Green
OOR	ON OFF REMOTE	Red Green White
SS	START STOP	Red Green
RESET	RESET	Black
EMERGENCY STOP	EMERGENCY STOP	Red

2.09 ELECTRICAL SURGE AND TRANSIENT PROTECTION

- A. General: Equip control panels with surge-arresting devices to protect equipment from damage due to electrical transients induced in interconnecting lines from lightning discharges and nearby electrical devices.
- B. Suppressor Locations:
1. At point of connection between each equipment item, including ac powered transmitters and its power supply conductors (direct wired equipment).
 2. On analog pairs at each end when the pair travels outside of building.
 3. In other locations where equipment sensitivity to surges and transients requires additional protection beyond that inherent to design of equipment.
- C. Power Supply Suppressor Assemblies:
1. Suitable for connection to 120-volt, single-phase power supplies EDCO "HSP SERIES."
 2. Suitable for connection to 480-volt, three-phase power supplies; Square D J9200-9A.
- D. Analog Signal Cable Suppressor Assemblies:
1. Epoxy encapsulated within a phenolic enclosure.
 2. Flame retardant.

3. Four lead devices; include a threaded mounting/grounding stud.
 4. Manufacturer and Product: EDCO; SRA-64 Series.
- E. Grounding: Coordinate surge suppressor grounding in field panels and field instrumentation as specified in Division 26, Electrical, and suppressor manufacturer's requirements. Furnish control panels with an integral copper grounding bus for connection of suppressors and other required instrumentation.

PART 3 EXECUTION

3.01 FACTORY TEST

- A. Submit a test for the Contractor's approval. Approval of the test plan is a prerequisite to actual factory test.
- B. Test all non loop-specific functions including, but not limited to, the following:
 1. Failure Mode and Backup Procedures: Power failure, redundant operation, auto restart, disk backup and reload, retentive outputs.
 2. Communication with PLC programmer.
 3. Man-Machine Interface: Operation of PLC with the specified industrially hardened operator interface.
 4. Programming and documentation methods and features.
- C. Test and debug all application programs to prove that each system works as specified.
- D. Test shall be unwitnessed.

3.02 OWNER TRAINING

- A. Provide a minimum of 2-days of training at the jobsite for the Owner's personnel in the operation of the PLC and for onsite hardware training for the Owner's instrument technicians in the maintenance of the OI and PLC hardware.
- B. Operations:
 1. Training shall include:
 - a. Standard operational features of system equipment provided.
 - b. Specific Features Provided for this Project Including:
 - 1) Loop functions.
 - 2) Operation of Each Loop: For example, AUTO/MANUAL control, control set point settings, control mode selection, alarm acknowledgment, use of operator interface.
 - 3) Interfaces with other loops and subsystems.

C. Hardware Maintenance:

1. Training shall Include:
 - a. Standard hardware features of the PLC and operator interface.
 - b. Specific training for the actual hardware configuration provided.
 - c. Test, adjustment, and calibration procedures.
 - d. Troubleshooting, component removal and replacement, and periodic maintenance.

3.03 O&M MANUALS

A. Hardware:

1. Provide the Following:
 - a. Updated versions of all material described under Paragraph Hardware Documentation.
 - b. Component Manufacturers' O&M Manuals: Include manuals to cover installation, operation, maintenance, troubleshooting, and calibration.
 - c. List of spare parts and expendables provided and list of spare parts recommended.

B. Software:

1. Provide the Following:
 - a. Programming Manuals: Component manufacturers' standard programming manuals.
 - b. Software Documentation: Provide a final version of the material called for under Paragraph Software Design Submittal.

3.04 ELECTRICAL POWER AND SIGNAL WIRING

- A. Restrain control and signal wiring in control panels by plastic ties or ducts. Secure hinge wiring at each end so bending or twisting will occur around the longitudinal axis of wire. Protect bend area with a sleeve.
- B. Arrange wiring neatly, cut to proper length, and remove surplus wire. Install abrasion protection for wire bundles passing through holes or across edges of sheet metal.
- C. Use manufacturer's recommended tool with sized anvil for crimp terminations. No more than one wire may be terminated in a single crimp lug. No more than two lugs may be installed on a single screw terminal.
- D. Do not splice or tap wiring except at device terminals or terminal blocks.

3.05 PROTECTION

- A. Protect enclosures and other equipment containing electrical, instrumentation and control devices, including spare parts, from corrosion through the use of corrosion-inhibiting vapor capsules.
- B. During Work, periodically replace capsules in accordance with capsule manufacturer's recommendations. Replace capsules at Substantial Completion.

END OF SECTION

SECTION 43 40 01
POLYETHYLENE STORAGE TANK

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American Society of Mechanical Engineers (ASME): B16.1, Cast Iron Pipe Flanges and Flanged Fittings.
2. ASTM International (ASTM):
 - a. C177, Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus.
 - b. D638, Test Method for Tensile Properties of Plastics.
 - c. D648, Test Method for Deflection Temperature of Plastics Under Flexural Load.
 - d. D746, Test Method for Brittleness Temperature of Plastics and Elastomers by Impact.
 - e. D790, Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.
 - f. D833, Standard Definitions of Terms Relating to Plastics.
 - g. D1505, Test Method for Density of Plastics by the Density-Gradient Technique.
 - h. D1525, Test Method for Vicat Softening Temperature of Plastics.
 - i. D1621, Test Method for Compressive Properties of Rigid Cellular Plastics.
 - j. D1622, Test Method for Apparent Density of Rigid Cellular Plastics.
 - k. D1623, Test Method for Tensile and Tensile Adhesion Properties of Rigid Cellular Plastics.
 - l. D1693, Test Method for Environmental Stress-Cracking of Ethylene Plastics.
 - m. D1940, Method of Test for Porosity of Rigid Cellular Plastics.
 - n. D1998, Specification for Polyethylene Upright Storage Tanks.
 - o. E84, Test Method for Surface Burning Characteristics of Building Materials.

1.02 DEFINITIONS

A. XLHDPE: Cross-linked high-density polyethylene.

1.03 DESIGN REQUIREMENTS

- A. Design Loads: In accordance with Section 01 61 00, Common Product Requirements.
- B. Manufacturer shall design bulk chemical storage tanks, including wall thickness and methods and locations of support and anchorage. Design shall be prepared and sealed by designer meeting requirements of Article Quality Assurance.

1.04 SUBMITTALS

- A. Action Submittals:
 - 1. Shop Drawings:
 - a. Fabricator's catalog information, descriptive literature, specifications, and identification of materials of construction. Provide catalog cuts for all off-the-shelf items.
 - b. Detailed fabrication drawings shall be scale drawings showing the relative size, configuration, location, materials of construction, and details of all equipment and materials to be furnished including the tanks, fittings, access ladders, supports, and tank holddown and support systems. Both plan and elevation views shall be provided. All piping terminal points shall be clearly shown and fully dimensioned.
 - c. Resin used for each tank and all supporting specifications for resins.
 - d. Complete design calculations for tanks, supports and appropriate accessories. Diagrams and calculations shall be provided that indicate all static and dynamic loads. Reactions (uplift, shear, gravity loads) shall be indicated for each of the applicable loading combinations found in the 2012 International Building Code. Calculations for anchor bolt type, size, and location shall be indicated for the controlling load combination.
 - e. Tank data indicating pressure rating, diameter, straight shell lengths, overall lengths, wall thickness, and details of nozzle designs.
 - f. Tank capacity chart indicating gallons for each inch of depth and cumulative total from bottom.
 - g. Certified test data on representative samples of standard materials which demonstrate compliance with the physical properties specified herein.
 - h. Certified copy of all factory test results including gel tests, impact tests, and hydrostatic tests. Provide a listing of procedures used in testing.

- i. Installation instructions shall be completed, detailed, and sequenced instructions for original installation. Recommended methods for assembly and adjustment including all bolt torques shall be provided along with special precautions and the sequence of work. Rigging and lifting details shall also be included for all factory-fabricated assemblies and individual components weighing over 100 pounds.
- j. All exceptions and any proposed revisions to the requirements of the Specifications shall be included with the Submittals.
- k. Calculations and Shop Drawings shall be signed and sealed by a professional engineer registered in the State of Georgia.

B. Informational Submittals:

- 1. Complete design calculations for tank, supports, and accessories.
- 2. Fabricator's Certificate of Compliance with fabrication requirements.
- 3. Anchorage and bracing calculations as required by Section 01 88 15, Anchorage and Bracing.
- 4. Equipment Seismic Certification as required by Section 01 45 36, Equipment Seismic Certification
- 5. Quality Assurance Submittal:
 - a. Qualifications of Fabricator's Quality Assurance Supervisor.
 - b. Initial QA Inspection Report.
 - c. Certification of Factory Testing.
- 6. Special shipping, storage and protection, and handling instructions.
- 7. Fabricator's written/printed installation and tank support instructions.
- 8. Manufacturer's Certificate of Proper Installation.
- 9. Operation and Maintenance Data: As specified in Section 01 78 23, Operation and Maintenance Data.

1.05 QUALITY ASSURANCE

- A. Fabricator's Quality Assurance Supervisor: Minimum of 5 years' experience in the fabrication of polyethylene storage tanks of similar size and usage.
- B. Tanks shall be manufactured by a firm with a nationally accepted quality standard (such as, ISO9001).

1.06 DELIVERY, STORAGE, AND HANDLING

- A. All materials fabricated to this specification must be packaged, crated, or protected in such manner so as to prevent damage in handling and while in transit. Details of these procedures shall be the responsibility of manufacturer.

- B. In addition, prepare and protect tanks for shipment as follows:
1. Mount tanks on padded cradles if shipped horizontally or on a suitable skid if shipped vertically.
 2. Protect all flanged nozzles with wooden blinds bolted to the flange and having a diameter of 2 inches greater than the outside diameter of the flange.
 3. Provide either rigid plugs inside the ends to prevent deflection or wooden boxes for all unflanged components. Brace the open ends of tanks with a suitable stiffening member to prevent deflection.
 4. Do not ship components or other pieces loose inside the tanks.
 5. Load tanks with at least 2 inches clearance between the tank (including fittings) and the bulkheads or bed of the vehicle.
 6. Regardless of the mode of transportation, firmly fasten and pad all components to prevent shifting of the load or flexing of components while in transit.
 7. Nozzles or other fittings shall not be used for lifting.

PART 2 PRODUCTS

2.01 GENERAL

- A. All equipment specified herein shall be factory fabricated and assembled to the maximum extent possible requiring a minimum of field assembly. Field installation shall be limited to anchoring the tanks and making external piping connections.
- B. All equipment specified herein shall be suitable for contact with the stored chemicals.
- C. Like items of materials and equipment shall be the end products of one manufacturer in order to provide standardization for appearance operation, maintenance spare parts, and manufacturer's service.

2.02 MANUFACTURERS

- A. Poly Processing Company.
- B. Or Engineer approved equal.

2.03 SERVICE CONDITIONS

- A. Location: Outdoors.
- B. Ambient Air Temperature Range: 5 degrees F to 110 degrees F.
- C. Relative Humidity: Up to 100 percent.

- D. Operating Pressure: Atmospheric.
- E. Stored Materials:

Stored Materials		
Equipment	Chemical	Specific Gravity
Sulfuric Acid Tank	78% H ₂ SO ₄	1.7*

2.04 TANK DESIGN CRITERIA

- A. Seismic Importance Factor: See Section 01 45 36, Equipment Seismic Certification.
- B. Dead Loads: Design for loads from all attached piping.
- C. Hydrostatic Load: For specific gravities of stored materials specified herein. Tanks shall be designed to withstand the hydrostatic pressure resulting from a full tank.

2.05 TANK CONSTRUCTION

- A. Tanks specified herein shall be cross linked high-density polyethylene construction with interior anti-oxidant resistant linear HDPE liner and integrally mounted flanged outlet (IMFO) and shall meet or exceed all requirements of ASTM D1998.
- B. Tanks shall be vertical, flat bottom, dome top construction with translucent materials to allow observation of liquid level.
- C. Tank manufacturer must be capable of issuing gel test results per ASTM requirements.
- D. The XLHDPE tanks shall be constructed using the rotational molding process.
- E. Materials shall meet or exceed the following properties:

Parameter	ASTM Test	Requirement
Density	D1505	0.944 - 0.946 gm/cc
Environmental Stress, Cracking Resistance (F50)	D1693	1,000 hrs
Tensile Strength, Ultimate (2" min.)	D638	2,600 - 3,000 psi
Elongation at Break (2" min.)	D638	400%
Vicat Softening Point	D1525	240 degrees F

Parameter	ASTM Test	Requirement
Flexural Modulus	D790	100,000 psi
Brittleness Temperature	D746	-130 degrees F
Heat Distortion Temp	D648	67 degrees C
Polyethylene Notch Test (PENT)	F1473	>1,000 hours

2.06 TANK SUPPORT AND RESTRAINT SYSTEM

- A. Each tank and its associated attachments shall be structurally adequate for all tank design criteria specified herein.
- B. Provide a minimum of four Type 316 stainless steel holddown lugs, complete with plate, anchor bolts, nuts, and washers for proper anchoring of the tank. Actual number of holddown lugs shall be calculated with the tank full.
- C. All exposed metal surfaces not constructed of stainless steel shall be painted in accordance with and as specified in Section 09 90 00, Painting and Coating, System No. 4.

2.07 FITTINGS

- A. Tank fittings and openings shall be provided as shown on the Tank Data Sheet and located as shown on the Drawings.
- B. Provide fill pipe drop leg inside tank connecting to fill connection. Pipe drop leg shall extend down into tank interior and shall have a 45-degree elbow installed on its end to discharge to interior sidewall of tank. Drop leg shall be supported internally by a pipe support. Pipe support shall be a bolted fitting at tank sidewall.
- C. Fittings shall be CPVC compressive type, with long shank, deep cut threaded with dual wide nut assembly. End type of fittings for connection to facility piping shall be as shown in the Fitting/Opening Schedule.
- D. All flanged fittings shall be gasketed with materials compatible with the chemical service.
- E. Bolted fittings shall use Hastelloy C bolts with polyethylene-encapsulated heads and CPVC external flanges.
- F. All materials used in tank fitting assemblies shall be resistant to the stored chemicals. No wetted fittings or appurtenances shall be of metallic construction.

- G. Provide an Integrally Molded Flanged Outlet (IMFO) Fitting Flange Mate Assembly 3-inch threaded PVC/C-276 for the outlet connection.
- H. Provide a 2-inch flexible connector for both the outlet and drain connection.

2.08 ACCESSORIES AND APPURTENANCES

- A. All tank accessories and appurtenances shall be chemically compatible with the stored materials and shall be designed to withstand the hydrostatic pressure resulting from a full tank.
- B. Calibration Tape: Calibration tape shall be self-adhesive, translucent tape calibrated in multiples of 50 gallons or less. Strips shall use black numerals and tick marks to denote gallonage.
- C. Gaskets:
 - 1. Material compatible with chemical service, low torque, full face, ASME B16.1 dimensions, two concentric, convex, molded rings between center hole and bolt hole circle.
 - 2. Type: 1/4 inch thick, low torque, full face, ASME B16.1 dimensions.
- D. Pipe Supports:
 - 1. Provide pipe supports for the fill pipe, overflow pipe, and discharge pipe attached to the tank.
 - 2. Spacing of pipe supports shall be as recommended by the fabricator, but shall not be greater than 5 feet on center.
 - 3. Pipe supports shall allow removal of supported pipes.
 - 4. Complete with Hastelloy C bolts, nuts, washers, and other necessary hardware for easy field assembly.
- E. Lifting Lugs: Provide suitably attached for all tanks weighing over 100 pounds. Lifting lugs shall be bolted fittings in sidewall of tank. Bolted fittings shall be as specified herein.
- F. Anchor Bolts: Type 316, stainless steel bolts, sized by fabricator and at least 3/4-inch diameter, or as shown and as specified in Section 05 50 00, Metal Fabrications.
- G. Ladder: Shall be in accordance with and as specified in Section 06 82 00, Glass-Fiber-Reinforced Plastic.
 - 1. Ladder shall extend to floor of containment. See structural drawings for elevation difference between tank pad and containment floor. Ladder shall extend far enough from the tank to provide a minimum of 7 inches of clearance between the centerline of the ladder rungs and the vertical face of the tank pad.

2.09 SOURCE QUALITY CONTROL

- A. General: The tank fabricators shall have a quality control procedure adequate to ensure that all fabrication complies with these Specifications.
- B. Factory Tests:
 - 1. Impact Tests: A representative sample from each tank shall undergo a factory impact test. Impact test must meet the requirements of ASTM D1998.
 - 2. Gel Tests: A representative sample from each tank provided shall undergo a factory gel test, as prescribed by ASTM D1998.
 - 3. Hydrostatic Leak Tests:
 - a. Perform on each tank.
 - b. Fill to overflow nozzle; allow to stand for 24 hours with no visible leakage.
 - 4. Wall Thickness: Each tank shall have an actual wall thickness measurement taken at every 90 degrees, at each one foot elevation, up to three feet from the bottom of the tank.
 - 5. Reports: Certify, by signature, the results of the factory testing.

PART 3 EXECUTION

3.01 INSTALLATION

- A. In accordance with the manufacturer's written instructions.
- B. Contractor shall provide all supervision, labor, tools, construction equipment, incidental materials, and the necessary services required to complete the installation and testing of the equipment.
- C. Accurately place anchor bolts using templates furnished by the manufacturer or as otherwise recommended by manufacturer and as specified in Section 05 50 00, Metal Fabrications.
- D. Tanks shall be installed in such a manner that no stresses shall be applied to flanged outlet as per manufacturer's installation instructions.
- E. Uniform and level surface contact shall be made between all tank bottoms and the support foundations by means of grouting. Tanks shall be set in wet grout tapered from a point 1 inch higher at tank center to the foundation edges. Initially, grouting shall be finished to leave no voids. Tanks shall be settled down squeezing out excess grout in such a manner as to leave no voids in the tank bottom/foundation interface. The grout shall not be used to support any load, only to fill irregularities in the tank bottoms and foundations. The in-place tanks shall not be exposed to any loads until the grout has hardened.

- F. Bolt torques on gaskets shall be as recommended by the equipment manufacturer.

3.02 FIELD QUALITY CONTROL

A. Field Tests:

1. Hydrostatic Test: Storage tanks shall be filled with clean water to the overflow level after all connections have been made. There shall be no leakage, no signs of weeping, and no signs of capillary action over a period of 48 hours.
2. Quality control shall include a final inspection by Contractor and a written record of this final inspection.
3. After testing, the tanks shall be thoroughly cleaned and dried.

3.03 MANUFACTURER'S SERVICES

- A. A manufacturer's representative for the equipment specified herein shall be present at the Job Site and classroom designated by Owner for the minimum person-days listed for the services hereunder, travel time excluded:

1. 1 person-day for inspection and certification of the installation.

3.04 CHEMICALS SUPPLIED BY CONTRACTOR

- A. Owner to have storage tank filled with 78 percent sulfuric acid prior to functional and performance testing.

3.05 SUPPLEMENTS

- A. The supplement listed below, following "END OF SECTION", is part of this Specification:

1. Supplement 1, Tank Data Sheet, Sulfuric Acid Storage Tank.

END OF SECTION

SECTION 43 40 02
FIBERGLASS REINFORCED PLASTIC TANK

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American Society of Mechanical Engineers (ASME):
 - a. B16.5, Pipe Flanges and Flanged Fittings: NPS 1/2 through 24.
 - b. RTP-1, Reinforced Thermoset Plastic Corrosion Resistant Equipment.
2. ASTM International (ASTM):
 - a. C582, Standard Specification for Contact-Molded Reinforced Thermosetting Plastic (RTP) Laminates for Corrosion-Resistant Equipment.
 - b. D2583, Standard Test Method for Indentation Hardness of Rigid Plastics by Means of a Barcol Impressor.
 - c. D2584, Standard Test Method for Ignition Loss of Cured Reinforced Resins.
 - d. D3299, Standard Specification for Filament-Wound Glass-Fiber-Reinforced Thermoset Resin Corrosion-Resistant Tanks.
 - e. D4097, Standard Specification for Contact-Molded Glass-Fiber-Reinforced Thermoset Resin Chemical-Resistant Tanks.
 - f. E84, Standard Test Method for Surface Burning Characteristics of Building Materials.
 - g. E1067, Standard Practice for Acoustic Emission Examination of Fiberglass Reinforced Plastic Resin (FRP) Tanks/Vessels.
3. Occupational Safety and Health Act (OSHA): Part 1910.24, Subpart D, Walking-Working Surfaces.

1.02 DEFINITIONS

A. FRP: Fiberglass reinforced plastic.

1.03 DESIGN REQUIREMENTS

- A. Design Loads: In accordance with Section 01 61 00, Common Product Requirements.
- B. Design tank, including resin selection (unless specified), wall thickness, methods and locations of support, and stiffener requirements. Design shall be prepared and sealed by designer meeting requirements of Article Quality Assurance.

1.04 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
 - a. Fabricators catalog information, descriptive literature, specifications, and identification of materials of construction, including complete resin system information.
 - b. Letter from resin manufacturer stating that selected resin is suitable for intended service.
 - c. Detailed fabrication drawings.
 - d. Tank data indicating equipment number, pressure rating, diameter, straight shell lengths, overall lengths, wall thickness, corrosion barrier thickness, and details of nozzle designs.
 - e. Tank capacity chart indicating gallons for each 3 inches of depth and cumulative total from bottom.
 - f. Fabricator's detailed requirements for tank foundations.
 - g. Recommended bolt torque for bolted FRP connections.
 - h. Anchorage and bracing drawings and cut sheets, as required by Section 01 88 15, Anchorage and Bracing.

B. Informational Submittals:

1. Complete design calculations for tanks, supports and appropriate accessories, signed and sealed by an Engineer registered in the State of Georgia.
2. Anchorage and bracing calculations as required by Section 01 88 15, Anchorage and Bracing.
3. Fabricator's Certificate of Compliance with fabrication requirements.
4. Qualifications of Fabricator's Quality Assurance Supervisor.
5. Copy of fabricator's Quality Assurance Program.
6. Quality Assurance Inspection:
 - a. Qualifications of Independent FRP Quality Assurance Inspector.
 - b. Initial QA Inspection Report.
 - c. Certification of Factory Testing.
7. Component and attachment testing seismic certificate of compliance as required by Section 01 45 36, Equipment Seismic Certification.
8. Special shipping, storage and protection, and handling instructions.
9. Fabricator's printed installation and tank support instructions.
10. Manufacturer's Certificate of Proper Installation in accordance with Section 01 43 33, Manufacturers' Field Services.
11. Operations and Maintenance Manual: As specified in Section 01 78 23, Operation and Maintenance Data.

1.05 QUALITY ASSURANCE

- A. Fabricator's Quality Assurance Supervisor: Minimum of 5 years' experience in fabrication of fiberglass structures.
- B. Designer: Registered professional engineer licensed in State of Georgia.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. In accordance with Section 01 61 00, Common Product Requirements. In addition, prepare and protect tank for shipment as follows:
 - 1. Mount tank on padded cradles if shipped horizontally or on a suitable skid if shipped vertically.
 - 2. Protect flanged nozzles with wooden blinds bolted to flange and having a diameter of 2 inches greater than outside diameter of flange.
 - 3. Provide either rigid plugs inside ends to prevent deflection or wooden boxes for unflanged components. Brace open end of tank with suitable stiffening member to prevent deflection.
 - 4. Do not ship components or other pieces loose inside tank.
 - 5. Load tank with at least 2 inches of clearance between tank (including fittings) and bulkheads, or bed of vehicle.
 - 6. Regardless of mode of transportation, firmly fasten and pad components to prevent shifting of load or flexing of components while in transit.

1.07 SEQUENCING AND SCHEDULING

- A. Do not ship tank from factory until Engineer's review of Certification of Factory Testing is completed.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Augusta Fiberglass.
- B. Belding.
- C. No substitutes.

2.02 SUPPLEMENTS

- A. Some specific requirements relative to this section are attached as supplements at the end of section.

2.03 SERVICE CONDITIONS

- A. Operating Pressure: Atmospheric.

2.04 MATERIALS

- A. Filament-Wound: Fabricate in accordance with ASTM D3299, Type I, Grade 1.
- B. Resin:
1. Suitable for intended service.
 2. Premium grade and corrosion resistant, such as chlorendic polyester, vinyl ester, or bisphenol A fumarate polyester.
 3. Use same resin throughout entire tank shell.
 4. Add ultraviolet absorbers to surfacing resin to improve weather resistance.
 5. No dyes, pigments, or colorants, except in exterior gel coat.
 6. No fillers or thixotropic agents.
 7. Curing System:
 - a. As recommended by resin manufacturer or as specified herein.
 - b. Cure products as specified in ASTM D3299.
 - c. Measure Barcol hardness according to ASTM D2583.
 8. Post-cure tank and appurtenances in accordance with resin manufacturer's recommendation for time and temperature. Post-curing should be completed with warm-to-hot dry air, free of combustion products. Hot spots shall be avoided.
- C. Reinforcements:
1. Surfacing Veil: Chemical surfacing mat, two layers of polyester fabric, 12 mils to 16 mils thick, with a finish and a binder compatible with the lay-up resin.
 2. Other Reinforcements: In accordance with ASTM D3299.
- D. Laminate:
1. Consists of inner surface (corrosion barrier), interior layer, and exterior layer (structural layer).
 2. Meet visual acceptance criteria in ASTM C582.
 3. Meet requirements of mechanical properties in ASTM D3299.
 4. Reinforce inner surface with resin-rich surfacing veil as specified herein.
 5. Apply a white color coat after inspection of laminate has been completed.

E. Marking:

1. Identify each tank with fabricator's name, capacity in gallons, maximum temperature, design pressure/vacuum, specific gravity, pH, resin, minimum thickness, tank number, tank name, and date of manufacture.
2. Provide permanent marking. Seal decals, labels, etc., into laminate exterior with clear resin.

F. Nozzles:

1. Gusset 4-inch or smaller nozzles with conical or plate type gussets. Larger nozzles shall be gusseted, if noted.
2. Finish flush with inside surface of tank, unless otherwise indicated.
3. Gaskets:
 - a. Provide two per nozzle, 1/8-inch-thick, full-face elastomeric material having a hardness of Shore A60 plus or minus 5.
 - b. Material shall be suitable for intended service.
4. Flanged Nozzles: Rated at 100 psi, with other dimensions and bolting corresponding to ASME B16.5 for 150-pound steel flanges.
5. Back face of flanges shall be spot-faced, flat and parallel to flange face of sufficient diameter to accept SAE metal washer under bolthead or nut.
6. Back face of flanges shall be spot-faced, flat and parallel to flange face of sufficient diameter to accept SAE metal washer under bolthead or nut.
7. Drain and outlet nozzle to be where the centerline of the nozzle is the same elevation as the bottom of the tank.

2.05 TANK INSULATION AND HEAT TRACING

A. Heat trace and insulate tank as specified below.

B. Casing Design for Insulated Tanks:

1. Tanks shall be fabricated as described above, but should additionally include an outer casing, integral with the tank, enclosing 2 inches of polyurethane foam insulation on the entire straight shell height of the tanks.
2. The insulated tanks shall have a U-factor at the tank wall and top of not more than 0.1 BTU per hour per square foot per degree F.
3. Casing design shall incorporate all requirements for top and size connections, as specified herein and shown on the Drawings.
4. The top head insulation casing shall be a minimum 1/4-inch thick chopped strand mat layer.
5. The side shell insulation casing shall be a minimum of 1/8-inch thick filament-wound layer using continuous woven roving.

6. Expansion joint(s) shall be installed in the insulation casing to allow free movement of tank and insulation casing. The expansion joint(s) shall be sealed off from water infiltration.
7. Apply heat tracing and insulation at time of tank manufacturer.

C. Tank Insulation:

1. Insulation used shall be polyurethane foam with a "R" value of 8.33 inches.
2. Polyurethane foam shall be applied with a nominal thickness of 2 inches to all external tanks, except the tank bottom shell.
3. Upon completion of application and curing of insulation, the polyurethane foam shall be coated with two full coverage coats of manufacturers' recommended latex mastic.

D. Tank Heat Tracing:

1. Install electrical heat tracing tape in the tank bottom with 100-mil layer of resin and chopped fiberglass strand, and exterior pigmented gel coat.
2. Operate from 115-volt, 60-Hz single phase AC with necessary NEMA 4X thermostats and temperature controls.
3. Delta T of 60 degrees F to be maintained.
4. Mount heating panels to tanks in accordance with the manufacturers' instructions. Heat tracing to be complete system, including heat panel, control thermostat, and installation kit.

2.06 APPURTENANCES

A. Supports:

1. Pipe Supports:
 - a. Provide for tank overflow pipes, internal and external fill piping.
 - b. Spacing of supports shall be as recommended by fabricator, but shall not be greater than 4 feet on center.
 - c. As shown on Drawings, shall allow removal of pipe.
 - d. FRP complete with necessary bolts, nuts, and washers.
2. Level Probe Supports: FRP.

B. Ladders:

1. Material: FRP as specified in Section 06 82 00, Glass-Fiber Reinforced Plastic.
2. Fasteners: FRP.
3. Supports, FRP: Locate as required for field installation of ladders, platforms, or handrails.

4. For tanks under roof or canopy, provide overhead clearance in accordance with OSHA 1910.24.
 5. Ladder shall extend to floor of containment. See structural drawings for elevation difference between tank pad and containment floor. Ladder shall extend far enough from the tank to provide a minimum of 7 inches of clearance between the centerline of the ladder rungs and the vertical face of the tank pad.
- C. Lifting Lugs: Provide suitably attached for tank weighing over 100 pounds.
- D. Anchor Bolts: Type 316 stainless steel bolts, sized by fabricator, and as shown on Drawings and as specified in Section 05 50 00, Metal Fabrications.
- E. Manway Bolts: Type 316 stainless steel bolts and nuts as specified in Section 05 50 00, Metal Fabrications.
- F. Tank Insulation and Heat Tracing: In accordance with Section 40 05 33, Heat Tracing.

2.07 SOURCE QUALITY CONTROL

- A. Factory Test Reports:
1. Certify results, by signature, of the following:
 - a. Inspections.
 - b. Results of hydrostatic testing.
 - c. Test reports of physical properties of standard laminates.

PART 3 EXECUTION

3.01 INSTALLATION

- A. In accordance with fabricator's written instructions.
- B. Accurately place anchor bolts using templates furnished by fabricator, and as specified in Section 05 50 00, Metal Fabrications.

3.02 FIELD QUALITY CONTROL

- A. Functional Test:
1. Conduct on each tank.
 2. Hydrostatic leak test with tank full of clean water. Allow water to stand for 24 hours to verify no leakage.

3.03 MANUFACTURER'S FIELD SERVICES

- A. Provide fabricator's representative at Site in accordance with Section 01 43 33, Manufacturers' Field Services, and Section 01 91 14, Equipment Testing and Facility Startup for installation assistance, inspection and certification of proper installation for specified component, subsystem, equipment, or system.

3.04 CHEMICALS SUPPLIED

- A. Owner to have storage tanks filled with Purate® prior to functional or performance testing.

3.05 SUPPLEMENTS

- A. The supplements listed below, following "End of Section," are part of this specification.
 - 1. Supplement 1, Tank Data Sheet, Purate Tank.

END OF SECTION

[illegible]

**SECTION 44 22 01
CHLORINE DIOXIDE GENERATOR**

PART 1 GENERAL

1.01 WORK OF THIS SECTION

- A. The Work of this section includes the fabrication, delivery, and placement into successful operation of a chlorine dioxide generator and accessories. The supplied chlorine dioxide generator system shall be capable of producing 169 pounds/day of chlorine dioxide.
- B. Unit Responsibility:
 - 1. The Work requires that the chlorine dioxide generator, complete with all accessories and appurtenances, be the end product of one responsible system manufacturer or responsible system supplier.
 - 2. The Contractor shall obtain the generation system from the responsible Supplier of the equipment. The supplier shall furnish all components and accessories of the system to enhance compatibility, ease of operation and maintenance, and as necessary to place the equipment in operation in conformance with the specified performance, features and functions. The Contractor shall install the equipment as required by the manufacturer to provide a complete system.
 - 3. Contractor shall be responsible for coordinating with package system vendor to ensure proper communications between systems. Package vendor shall be responsible for setting up and testing their system to ensure that data gets to/from the appropriate data tables/registers within their system. Upon verification that data has been placed in the appropriate location, contractor shall assume responsibility for getting the data to/from the PICS provided control system.
- C. General Requirements: See Division 1, General Requirements, which contains information and requirements that apply to the Work specified herein and are mandatory for this Project.

1.02 EQUIPMENT AND COMPONENT NUMBERS

- A. Chlorine Dioxide Generator (SVP-Pure Model# AD8): M-210-1.
- B. Water Booster Pump: P-211-2.
- C. Chlorine Dioxide Analyzer: AE/AIT-210-9.

1.03 SUBMITTALS

A. Action Submittals:

1. Drawings and sections of skids including overall dimensions, locations of chemical pipe connection points, and water connection point.
2. Anchorage requirements.
3. Wiring diagrams.
4. P&IDs.
5. See Section 40 99 90, Package Control Systems for control panel submittal requirements.
6. See Section 40 90 01, Instrumentation and Control for Process Systems for instrumentation component submittal requirements.
7. Complete cut sheets and manufacturer information for any purchased subcomponents used by the manufacturer.

B. Informational Submittals:

1. Special shipping, storage and protection, and handling instructions.
2. Manufacturer's printed installation instructions with anchoring details.
3. Manufacturer's Certificate of Proper Installation.
4. Operation and Maintenance Manuals.
5. Factory and Field Performance Testing.

C. Source Quality Control: Chlorine dioxide generator feed system shall be preassembled and shop tested to assure system provided will meet performance requirements.

1.04 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. Product delivery, storage, and handling shall comply with Division 1, General Requirements.

1.05 QUALITY ASSURANCE

- A. The selected supplier shall assume overall responsibility and provide functional and operational guarantees for the generator based on the designed system and all associated equipment.

1.06 WARRANTY

- A. Purate® chlorine dioxide generator shall be warranted against defects in materials and workmanship for a period of 12 months from startup.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Where a manufacturer's standard equipment name and/or model number is listed, the equipment system shall be provided as modified to conform to the performance, functions, features, and materials of construction as specified herein.
- B. Materials, equipment, components and accessories specified in this section shall be products of Nalco Chemicals, Inc., as supplied by:
 - 1. Water Solutions, LCC, Cherry Log, GA, 706-635-0635 (Mobile: 678-983-0635).
 - 2. No substitutes.

2.02 SERVICE CONDITIONS

- A. Performance Requirements:
 - 1. Dosage: 0.25 to 1.50 mg/l of chlorine dioxide.
 - 2. Plant Flows: 3 mgd to 9.3 mgd.
 - 3. Production Requirement for maximum condition (flow and dose): 116.4 pounds per day of chlorine dioxide .
- B. The chlorine dioxide generator shall be located in the Chlorine Dioxide room of existing Chemical Building:
 - 1. The ambient air temperature will be 40 degrees F to 100 degrees F.
 - 2. The carrier water (W2) temperature will be 40 degrees to 90 degrees F.
 - 3. There will be 8 gpm of W2 water provided to the Chlorine Dioxide Generator Skid for carrier/eductor water service. A minimum of 100 and maximum of 140 psig shall be available at the eductor provided by the booster pump.
- C. Application Point Information:
 - 1. Raw Water Injection Point:
 - 1) The chlorine dioxide solution will continue to be injected into the existing 24-inch raw water pipeline inside the chemical injection trench in the fluoride room of the Chemical Building. Pressure at Injection Point: up to 10 psig.
 - a) Length from Generation Point to Injection Point: Approximately 85 feet.
 - b) Diameter of Piping: 1-1/2 inches.

2.03 SYSTEM PERFORMANCE REQUIREMENTS

- A. Chlorine Dioxide Generators shall utilize the Following Chemicals:
 - 1. Purate®.
 - 2. Sulfuric Acid: (78 percent).
- B. The generator shall be capable of producing from 9.4 to 169 pounds per day of chlorine dioxide and maintain a minimum yield efficiency of 95 percent chlorine dioxide from the reaction of Purate® and 78 percent sulfuric acid.
- C. The chlorine dioxide generator shall maintain the specified minimum yield efficiency of 95 percent over a 10 to 1 feed range based on the maximum capacity of the generator.
- D. The generation of chlorine dioxide shall take place under vacuum.

2.04 SYSTEM DESIGN REQUIREMENTS

- A. Yield Determination Analysis:
 - 1. The minimum yield of chlorine dioxide from the reaction of the specified chemicals shall be 95 percent. Yield shall be defined as the ratio of chlorine dioxide actually generated to the theoretical stoichiometric maximum.
 - 2. The yield will be demonstrated by an amperometric analysis capable of differentiating between chlorine, chlorine dioxide, chlorite and chlorate. Analysis shall be confirmed by AWWA Standard Method 4500-ClO₂E. The theoretical stoichiometric maximum shall be determined from the feed rates of the reacting chemicals.
- B. Chlorine Dioxide Generation Method:
 - 1. Chlorine dioxide shall result from the complete reaction of Purate® with sulfuric acid in a reactor prior to dilution with water. The reaction shall be assisted with a water operated eductor provided on the generator skid.
 - 2. Purate® and sulfuric acid shall be fed to the reactor using chemical metering pumps. These shall be provided by the Supplier as part of the generator skid.
 - 3. The Purate® and sulfuric acid shall react instantaneously in a reactor vessel creating chlorine dioxide at a high-yield efficiency. The water used in the eductor shall dissolve the formed chlorine dioxide gas in the eductor/carrier water stream for delivery to the application point at concentrations between 100 and 2,000 mg/L. A sampling port shall be provided where the chlorine dioxide solution exits the generator. A sight glass shall also be provided where the chlorine dioxide solution exits the generator.

2.05 WATER BOOSTER PUMP

- A. Components: Vertical multi-stage centrifugal pump with controls; configured as shown on the Drawings.
- B. Pump:
 - 1. Equipment Tag No: P-211-2.
 - 2. Capacity: As determined by the chlorine dioxide generator supplier to meet the field conditions.
 - 3. 1-1/4-inch NPT discharge connection.
 - 4. Pump Manufacturer: Grundfos.
- C. Motor:
 - 1. Rating: 1.5 horsepower, 480 -volt, 3-phase, 60Hz.
 - 2. Shall be totally enclosed, fan-cooled, 2-pole frequency-controlled motor. Motor shall be invert duty rated.
- D. Motor Controls: The pump motor shall be provided with frequency converter and PI-controller integrated in the motor terminal box. Motor and electronics shall be protected by integral overload and temperature protection. Pump control shall be provided locally on pump motor.

2.06 EQUIPMENT AND/OR MATERIALS

- A. Materials of construction shall be suitable for a chemical feed facility environment as recommended by the chlorine dioxide system manufacturer.
- B. All materials inside the generator that are in contact with Purate[®], chlorine dioxide, and sulfuric acid shall be Schedule 80 CPVC, Teflon, Viton, Kynar, or Halar.
- C. All coatings shall be as recommended by the chlorine dioxide system manufacturer and appropriate for the chemical feed facility environment. It is the responsibility of the chlorine dioxide system supplier to ensure that the coatings utilized are appropriate.

2.07 ACCESSORIES

- A. Anchor bolts shall be appropriately sized in accordance with Section 01 88 15, Anchorage and Bracing. Anchoring to be coordinated with Contractor.
- B. Chlorine dioxide generators shall include a nameplate, indicating the manufacturer, equipment tag number, and date of manufacture.
- C. Provide separate containment trays in the base of the generator cabinet to contain leaks of Purate and sulfuric acid inside the cabinet.

2.08 ELECTRICAL COMPONENTS AND ACCESSORIES

- A. General: Provide field panels, electrical components and wiring for a complete, functional system. Provide all items not specifically specified which are required to implement the specified functions and the functions required for proper system operation.

2.09 CONTROLS

- A. In accordance with general requirements and component qualities specified in Section 40 99 90, Package Control Systems, and as follows:

Panel No.	Name	NEMA Rating	Material
CP-210	Chlorine Dioxide Generator Control Panel	12	Powder Coated Steel

- B. Panels: Panels shall contain operator interface unit and local control devices, circuit breakers, motor starters, and programmable logic controller system.
- C. Terminate and identify wires entering or leaving enclosures as follows:
1. Analog and discrete signal, terminate at numbered terminal blocks.
 2. Special signals terminated using manufacturer's standard connectors.
 3. Identify wiring in accordance with requirements in Section 26 05 01, Electrical.
- D. Operators Controls and Indicators: Operator interface unit: On the Operator Interface Unit, display discrete status and alarms; Manual/Off/Auto control selection of all process equipment, analog process variables such as flow, and analog equipment variables such as pump speed.
- E. External Interfaces:
1. For Each Generator System:
 - a. Provide Contact Closure Output for:
 - 1) Generation System FAIL.
 - 2) Generation System ON Status.
 - 3) Booster Pump RUN COMMAND.
 - b. Receive a Contact Closure Input for: Generation System RUN COMMAND.
 - c. Receive an Analog Input for: Chlorine dioxide Production Setpoint (lbs/hr).
 - d. Provide 4 to 20 mA Analog Output for: Chlorine dioxide production (lbs/hr).
 2. Provide an Ethernet TCP/IP connection to the Plant SCADA system. Provide a detailed list of available signals and parameters.

- F. Functional Requirements: Direct feed chlorine dioxide solution from the generation system. Feed based on an analog signal for production setpoint and run command with generator in REMOTE mode.
- G. Power Requirements: 120 volts, single-phase.
- H. Special Requirements:
 - 1. Provide a chlorine dioxide analyzer that utilizes a sensor and photometric converter to accurately provide true chlorine dioxide concentration measurement. This analyzer shall be used to monitor and calculate the chlorine dioxide production. The chlorine dioxide analyzer shall be manufactured by Optek. All components shall be NEMA 4X.
 - 2. The PLC shall be Siemens S7-1200 components and shall be capable of communicating with the plant's existing control system via hard wired connections and Ethernet TCP/IP.
 - 3. Provide a magmeter for measuring plant water flow to generator. Flow meter shall be IFM Model SM2001.
 - 4. Valves included in package shall be provided by manufacturer.
 - 5. Provide a vacuum transmitter for measuring the differential pressure across the eductor.
 - 6. Power for the reactor, instrumentation, valves, acid and Purate pumps shall be provided from the control panel.
 - 7. The control cabinet shall be provided with surge suppressors on the 120V ac lines and all analog signals entering or leaving the panel.
 - a. For 120V ac Lines: Phoenix Contact Part Number 2839282 Base with Part Number 2839334 Plug.
 - b. For Analog Signals Lines: Phoenix Contact Part Number 2838186.

2.10 FABRICATION

- A. Shop Assembly: Generator skid should arrive on site fully factory assembled. Care should be taken during shipment to protect skid and skid components.
- B. Shop/Factory Finishing: Shop prime and finish coatings as recommended by the chlorine dioxide system manufacturer.

2.11 SOURCE QUALITY CONTROL

- A. Factory Performance Test (FPT): Perform an unwitnessed documented FPT of the control system. Submit documentation to the Engineer prior to startup of the system.

2.12 TOOLS, SPARE PARTS, AND MAINTENANCE MATERIALS

- A. The chlorine dioxide generation system shall be furnished with the following spare parts:
1. One PLC with final program loaded.
 2. One water booster pump.
 3. One Purate® metering pump.
 4. One sulfuric acid metering pump.
 5. One metering pump repair kit.
 6. One IFM SM2001 magmeter.
 7. Two 1/2-inch FNPT BPTA-050-P Griffco CPVC Back Pressure Regulator.
 8. Four 1-inch (25 DIN) Asahi Gaskets (Teflon/EPDM).
 9. Two 2-inch (50 DIN) Asahi Gaskets (Teflon/EPDM).
 10. One 3-inch (75 DIN) Asahi Gaskets (Teflon/EPDM).
 11. Four 1/2-inch Jaco CH906 Kynar Reactor Check Valves.
 12. Two 1/2-inch CPVC True Union Ball Valves.
 13. Two 1-inch CPVC True Union Ball Valves.
- 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.

PART 3 EXECUTION

3.01 GENERAL

- A. Packaged Equipment: When any system is provided as pre-packaged equipment, coordination shall include space and structural requirements, clearances, utility connections, signals, outputs and features required by the manufacturer including safety interlocks.

3.02 MANUFACTURERS' SERVICES

- A. Performance Testing: Test the chlorine dioxide generation system for proper operation. Demonstrate production at both minimum end of production range (adjust chemical feed rates if necessary) and at rated production. Submit test results to Engineer.

- B. Provide manufacturer's services and Manufacturer's Certificate of Proper Installation in accordance to Division 01, General Requirements, and as follows:
1. 1 person day and 1 trip by the chlorine dioxide generation system Manufacturer Representative to assist the Contractor with the installation, startup, functional and performance testing, and completion of Manufacturer's Certificate of Proper Installation.
 2. 1 person day and 1 trip by the chlorine dioxide generation system Manufacturer Representative for Owner training at Owner's request.
 3. Vendor shall have a factory trained representative with direct knowledge of the PLC control system on-site during the testing of the plant PLC/SCADA system.

END OF SECTION

PART 4

**DRAWINGS
(BOUND SEPARATELY)**
