CONTRACT DOCUMENTS FOR
CONSTRUCTION OF

CROSSTOWN WATER TREATMENT PLANT IMPROVEMENTS

BID #960-B

Fayette County Water System

PREPARED FOR THE

FAYETTE COUNTY WATER SYSTEM
FAYETTE COUNTY, GEORGIA

VOLUME 1 OF 2
SPECIFICATIONS

For information regarding this project, contact:

MICHAEL E. DIAZ, P.E.
6600 Peachtree Dunwoody Road
400 Embassy Row, Suite 600
Atlanta, GA 30328
770.604.9095

CH2MHILL®

Project No.
497074

MAY 2015

BID DOCUMENTS

FAYETTE COUNTY WATER SYSTEM

FAYETTE COUNTY, GEORGIA

BIDDING REQUIREMENTS
AND
CONTRACT DOCUMENTS

for the construction of the

CROSSTOWN WATER TREATMENT PLANT IMPROVEMENTS BID #960-B

****

****

CH2M HILL
Atlanta, Georgia
May 2015

Project No. 497074 Copy No._____

SECTION 00 01 07
SEALS PAGE

FAYETTE COUNTY WATER SYSTEM
FAYETTE COUNTY, GEORGIA

CROSSTOWN WATER TREATMENT PLANT IMPROVEMENTS

Front Ends, General Requirements and
Process Mechanical
Michael E. Diaz

Structural
David A Preissler

Architectural
Timothy M. Dodge

Electrical
Nicholas G. Meyer

I&C
Prabhakar Y. Keskar

Civil
Jose A. Ramos

Pages

TABLE OF CONTENTS

Pages

Pages

Pages

Pages

END OF SECTION

PART 1

PROCUREMENT REQUIREMENTS

INVITATION TO BID

Sealed Bids for construction of **Crosstown Water Treatment Plant Improvements Bid # 960-B**, addressed to 140 Stonewall Avenue West, Suite 204, Fayetteville, Georgia 301214, will be received at the office of the Fayette County Purchasing Department, Fayetteville, State of Georgia, until **3:00 p.m.**, local time, on the **16th** day of **June, 2015**. Any Bids received after the specified time will not be considered. Bids will then be publicly opened and read.

The Project generally consists of a new powdered activated carbon storage and feed system; a new chlorine dioxide storage and feed system; rehabilitation of the existing eight filters; selective demolition; yard piping for new and existing facilities; electrical system improvements to support new loads; computer-based controls associated with improvements; site development and storm water management.

The Work will be completed in all respects within 365 calendar days from the date when the Contract Times commence to run. Bidding Documents may be examined in Owner's Fayette County website at: http://www.fayettecountyga.gov/purchasing/bids_and_proposals.asp

Each Bid must be submitted on the prescribed Bid Form and accompanied by Bid security as prescribed in the Instructions to Bidders. The Successful Bidder will be required to furnish the additional bond(s) and insurance prescribed in the Bidding Documents. In order to perform public work, Bidder and its Subcontractors, prior to award of Contract, shall hold or obtain such licenses as required by State Statutes, and federal and local Laws and Regulations.

For information concerning the proposed Work, contact Trina C. Barwicks, Contract Administrator, Fayette County Purchasing Department, 140 Stonewall Ave. W., Suite 204, Fayetteville, GA 30214, Direct: (770) 305-5314, Fax: (770) 719-5515, Email: tbarwicks@fayettecountyga.gov.

Attendance at a prebid conference will be held at 10:00 a.m. local time on May 21, 2015 at Crosstown WTP, 3500 TDK Boulevard, Peachtree City, Georgia 30269, will be a mandatory requirement of submitting a Bid for this Project. Refer to Instructions to Bidders for additional information.

Owner's right is reserved to reject all Bids or any Bid not conforming to the intent and purpose of the Bidding Documents.

Dated this 29th day of April 2015.

Purchasing Department, Fayette County, Georgia

By _____
Ted L. Burgess, Director of Purchasing

END OF SECTION

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.

The information submitted in this form will be regarded as confidential.

BIDDER'S QUALIFICATION FORM

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:

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					

	No	Yes	Annually	Bi-Weekly	Monthly
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 (within last 8 years) 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 company ever been disbarred from Bidding? _____. If so, list below and state why?

_____

13. Has the company ever been involved in bankruptcy proceedings? _____. If so, list below and state why? _____

Bidder's Financial Statement

Certified Financial Statements may be submitted in lieu of preparation of this special financial statement if all requested information is contained in statement.

NOTE: Complete the following information or attach the last balance sheet that covers a 12-month period and has been audited by a Certified Public Accountant.

Condition at close of business _____, 20____

ASSETS

Current Assets:

1. Cash	$_____	
2. Notes Receivable	$_____	
3. Accounts Receivable from completed contracts, exclusive of claims not approved for payment	$_____	
4. Sums earned on uncompleted contracts as shown by Engineer's or Architect's estimate	$_____	
5. Accounts Receivable from sources other than construction contracts	$_____	
6. Accounts Receivable from owners or employees	$_____	
7. Deposits for bids or other guarantees	$_____	
8. Interests accrued on loads, securities, etc.	$_____	
9. Negotiable securities, stocks, bonds, etc.	$_____	
10. Materials in stock not included in Item 4	$_____	
Total Current Assets		$_____

Fixed Assets:

11. Real Estate	$_____	
12. Construction Plant and Equipment, book value	$_____	
13. Furniture and Fixtures, book value	$_____	
14. Other Assets	$_____	
Total Assets		$_____

LIABILITIES AND CAPITAL

Current Liabilities:

1. Notes Payable (exclusive of equipment obligations)	$_____	
2. Accounts Payable	$_____	
3. Payroll and Related Payable	$_____	
4. Notes or Accounts Payable to owners or employees	$_____	
Total Current liabilities		$_____

Fixed or Secured Liabilities:

5. Real Estate Encumbrances	$_____	
6. Equipment Obligations secured by equipment	$_____	
Total Fixed Or Secured Liabilities		$_____

Liabilities and Capital:

7. Other Liabilities	$_____	
8. Reserves	$_____	
9. Capital Stock paid up	$_____	
10. Surplus (Net Worth)	$_____	
Total Liabilities and Capital		$_____

CONTINGENT LIABILITIES

1. Liability on Notes Receivable, discounted, or sold	$_____	
2. Liability on Accounts Receivable, pledged, assigned or solid	$_____	
3. Liability on Bondsman	$_____	
4. Liability as Guarantor on contracts or on Accounts of Others	$_____	
5. Other Contingent Liabilities	$_____	
Total Contingent Liabilities		$_____

The undersigned hereby declares that the foregoing statements are true and that the foregoing financial statement is a true and accurate statement of the financial condition of said firm.

Dated at _____ this ____ day of _____ 2010.

By _____

Title _____

Date _____

I have examined the financial records of the above company for the period ending _____ and, in my opinion, the statements present fairly the financial position of _____ at that date.

_____
Certified Public Accountant

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: http://www.fayettecountyga.gov/purchasing/bids_and_proposals.asp.

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. To demonstrate Bidder's qualifications to perform the Work, within 5 days of Owner's request, Bidder shall submit written evidence such as financial data, previous experience, and present commitments

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. Those reports and drawings are not part of the Contract Documents, but the "technical data" contained therein upon which Bidder is entitled to rely as provided in Paragraph 4.02 of the General Conditions has been identified and established in Paragraph 4.02 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. Hazardous Environmental Condition:

4.3.1. The Supplementary Conditions identify reports and drawings known to Owner relating to a Hazardous Environmental Condition identified at the Site.

4.3.2. Copies of reports and drawings referenced will be made available by Owner to any Bidder on request. Those reports and drawings are not part of the Contract Documents, but the "technical data" contained therein upon which Bidder is entitled to rely as provided in Paragraph 4.06 of the General Conditions has been identified and established in Paragraph 4.06 of the Supplementary Conditions. Bidder is responsible for any interpretation or conclusion Bidder draws from any "technical data" or any other data, interpretations, opinions, or information contained in such reports or shown or indicated in such drawings. Costs associated with making available copies of reports and drawings shall be borne by Bidder.

4.4. 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 Paragraphs 4.02 through 4.04 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 due to 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 4.06 of the General Conditions.

4.5. 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.

4.6. Related Work at Site: Reference is made to the General Requirements for identification of the general nature of other work that is to be performed at the Site by Owner or others (such as utilities and other prime contractors) that relates to the Work contemplated by these Bidding Documents. On request Owner will provide to each Bidder for examination, access to or copies of contract documents (other than portions thereof related to price) for such other work.

4.7. Safety: Paragraph 6.13.C of the General Conditions indicates that if an Owner safety program exists, it will be noted in the Supplementary Conditions.

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

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

4.8.2. 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.

4.8.3. 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.

4.8.4. Carefully study all:

4.8.4.1. 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 4.02 of the Supplementary Conditions as containing reliable “technical data”.

4.8.4.2. Reports and drawings of Hazardous Environmental Conditions, if any, at the Site that have been identified in Paragraph 4.06 of the Supplementary Conditions as containing reliable “technical data”.

4.8.5. 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:

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

4.8.5.2. 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.

4.8.5.3. Bidder's safety precautions and programs.

4.8.6. 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.

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

4.8.8. 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.

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

4.9. 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 **10:00 a.m.** local time on **May 21, 2015** at Crosstown WTP, 3500 TDK Boulevard, Peachtree City, Georgia 30269. 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 the 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. SITE AND OTHER AREAS

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

7. INTERPRETATIONS AND ADDENDA

7.1. 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 15 days prior to the date for opening of Bids may not be answered. Only questions answered by Addenda will be binding. Oral and other interpretations or clarifications will be without legal effect.

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

8. BID SECURITY

8.1. 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 5.01 and Paragraph 5.02 of the General Conditions.

8.1.1. In addition to types of Bid security listed above, a cashier's check will also be acceptable.

8.2. 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.

8.3. 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.

9. CONTRACT TIMES

9.1. 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.

10. LIQUIDATED DAMAGES

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

11. SUBSTITUTE AND "OR-EQUAL" ITEMS

11.1. 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.

12. PREPARATION OF BID

12.1. 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.

12.2. 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 and unit price item listed therein or the words "No Bid," "No Change," or "Not Applicable" entered.

12.3. 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.

12.4. 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.

12.5. 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.

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

12.7. 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.

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

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

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

12.11. 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.

13. BASIS OF BID; COMPARISON OF BIDS

13.1. Lump Sum:

13.1.1. Bidders shall submit a Bid on a lump sum basis as set forth in the Bid Form.Unit Price:

13.2.1. Bidders shall submit a Bid on a unit price basis for each item of Work listed in the Bid schedule.

13.2.2. The total of all estimated prices will be the sum of the products of the estimated quantity of each item and the corresponding unit price. The final quantities and Contract Price will be determined in accordance with Paragraph 11.03 of the General Conditions.

13.2.3. Discrepancies between the multiplication of units of Work and unit prices will be resolved in favor of the unit prices. Discrepancies between the indicated sum of any column of figures and the correct sum thereof will be resolved in favor of the correct sum.

13.3. Allowances:

13.3.1. Cash Allowance:

13.3.1.1. 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.

13.3.1.2. As described in the Bid Form, General Conditions Paragraph 11.02, and Section 01 29 00, Payment Procedures.

14. SUBMISSION OF BID

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

14.1.1. Bidder's Experience.

14.1.2. Bidder's Qualification.

14.1.3. List of Project References.

14.1.4. Certificate of Bidder Regarding Equal Opportunity.

14.1.5. 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.

14.1.6. Contractor's License No.

14.1.7. Statement of Noncollusion.

14.2. 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 (and, if applicable, the designated portion of the Project for which the Bid is submitted), 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."

15. MODIFICATION AND WITHDRAWAL OF BID

15.1. 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.

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

16. OPENING OF BIDS

16.1. 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 and major alternates, if any, will be made available to Bidders after the opening of Bids.

17. BIDS TO REMAIN SUBJECT TO ACCEPTANCE

17.1. 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.

18. EVALUATION OF BIDS AND AWARD OF CONTRACT

18.1. Owner reserves the right to reject any or all Bids, including without limitation, nonconforming, nonresponsive, unbalanced or conditional Bids. Owner further reserves the right to reject the Bid of any Bidder whom it finds, after reasonable inquiry and evaluation, to not be responsible. Owner may also reject the Bid of any Bidder if Owner believes that it would not be in the best interest of the Project to make an award to that Bidder. Owner also reserves the right to waive all informalities not involving price, time, or changes in the Work and to negotiate contract terms with the Successful Bidder.

18.2. 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.

18.3. In evaluating Bids, Owner will consider whether or not the Bids comply with the prescribed requirements, and such alternates, unit prices, and other data, as may be requested in the Bid Form or prior to the Notice of Award.

18.4. 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.

18.5. 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.

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

19. CONTRACT SECURITY AND INSURANCE

19.1. Article 5 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 and certificates of insurance.

20. SIGNING OF AGREEMENT

20.1. 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:

20.1.1. 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.

20.1.2. Contractor further agrees that such compliance shall be attested by Contractor and its Subcontractors by execution of the appropriate Contractor Affidavit and Agreement and Subcontractor Affidavit forms included in Contract Documents.

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

20.2.1. Register with Commissioner and pay fee.

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

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

20.3. 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.

21. RETAINAGE

21.1. 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
(STIPULATED PRICE BASIS)

1. BID RECIPIENT

1.1. This Bid is submitted to:

Owner:	Fayette County, Georgia
Address:	Purchasing Department, 140 Stonewall Avenue West, Suite 204, Fayetteville, Georgia 301214
Project Identification:	Crosstown Water Treatment Plant Improvements Bid #960-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 4.02 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 4.06 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. OWNER PRESELECTED EQUIPMENT

5.1. Owner has preselected and has pre-negotiated the cost of the materials or equipment items shown in the table. The scope of equipment and services to be provided by each supplier is provided in the Specifications. The Bidder agrees that payment for the scope of equipment and services by each supplier as shown in the Specifications is included in the Lump Sum Work. Taxes are not include in the amounts listed below.

Specification Section No.	Preselected Equipment Name and Manufacturer	Negotiated Price
40 99 91 44 43 34	Filter Package Control System Filter Underdrain System	$1,572,500.00
44 43 30	Filter Media	$209,043.00

* Includes option adders Filter Magic Remote Access System ($9,900.00), Backwash ROF 20” Venturi w/ Transmitter and 20” Valve w/ Electric Actuator ($25,600.00), and four NEMA 12 Filter Magic “Slave” Filter Control Consoles ($42,000.00).

6. PICS SUPPLIERS

6.1. Bidder shall use one of the Listed PICS supplier below, for the Process Instrumentation Control Systems (PICS) specified in Section 40 90 01, Instrumentation and Control for Process Systems. Bidder shall circle the name of the PICS Supplier. In the event that the Bidder fails to circle one of the named PICS Suppliers, the first named PICS supplier shall be used for the Project. Owner specifying the Supplier does not exempt Contractor or Supplier from meeting the requirements of the Contract Documents; nor does it give prior approval of subsystems, equipment, materials, or services.

Listed PICS Suppliers	
Industrial Control Systems	Sandstone, VA
M/R Systems	Norcross, GA
Industrial Controls Systems, Inc.	Sandston, VA
Revere Control Systems	Birmingham, AL
J.K. Duren Company	Roswell, GA
Kapsch (Transdyn Controls)	Duluth, GA

7. BASIS OF BIDS

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

7.2. Lump Sum Bid Price: $_____

7.3. Unit Price Bid Schedule:

7.3.1. Unit prices have been computed in accordance with Paragraph 11.03.C of the General Conditions.

7.3.2. Bidder acknowledges that estimated quantities are not guaranteed, and are solely for the purpose of comparison of Bids, and final payment for all unit price Bid items will be based on actual quantities, determined as provided in the Contract Documents.

Unit Price Bid Schedule					
Item No.	**Description**	**Estimated Quantity**	**Unit**	**Bid Unit Price**	**Extended Bid Unit Price**
1.	Removal of Unsuitable Materials and Replacement with Compacted Granular Fill	100	cu yd	$	$
				Total of Extended Bid Unit Prices	**$**

7.4. Base Bid Summary:

7.4.1. Lump Sum Bid Price: $_____

7.4.2. Total Extended Unit Bid Prices: $_____

7.4.3. Base Bid (Total of Above): $_____

7.5. Cash Allowance(s):

7.5.1. Unforeseen Work Elements

Item	**Description**	**Allowance**
1.	Unforeseen Work Elements	$40,000.00
	Total Amount For Allowances	$40,000.00

7.5.2. Materials Testing Laboratory

Item	**Description**	**Allowance**
1.	Materials Testing Laboratory	$10,000.00
	Total Amount For Allowances	$10,000.00

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

8. TIME OF COMPLETION

8.1. Bidder agrees the Work will be substantially complete within 335 calendar days after the date when the Contract Times commence to run as provided in Paragraph 2.03 of the General Conditions, and will be completed and ready for final payment in accordance with Paragraph 14.07 of the General Conditions within 365 calendar days after the date when the Contract Times commence to run.

8.2. 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.

9. ATTACHMENTS TO THIS BID

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

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

9.1.2. Bidder's Experience.

9.1.3. Bidder's Qualification.

9.1.4. List of Project References.

9.1.5. 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.

9.1.6. Contractor's License No.

9.1.7. Noncollusion Affidavit.

10. DEFINED TERMS

10.1. 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.

11. BID SUBMITTAL

11.1. 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 (*state where Project is located*) 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

BID BOND

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

BIDDER (Name and Address):

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

OWNER (Name and Address):

BID

Bid Due Date:
Project (Brief Description Including Location):

BOND

Bond Number:
Date (Not later than Bid due date):

Penal sum _____ _____
(Words) (Figures)

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

BIDDER	SURETY
_____(Seal)	_____(Seal)
Bidder's Name and Corporate Seal	Surety's Name and Corporate Seal
By: _____	By: _____
Signature and Title	Signature and Title (Attach Power of Attorney)
Attest: _____	Attest: _____
Signature and Title	Signature and Title

Note: Above addresses are to be used for giving required notice.

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

SECURITY AND IMMIGRATION COMPLIANCE ACT

The Contractor agrees that compliance with the requirements of O.C.G.A. Sec. 13-10-91 and Rule 300-10-1 of the rules of the Georgia Department of Labor are conditions of this Agreement for the physical performance of services.

The Contractor further agrees that its compliance with the requirements of O.C.G.A. Sec. 13-10-91 and DOL Rule 300-10-1-02 is attested to on the executed Contractor Affidavit and Agreement attached hereto as EXHIBIT A.

If employing or contracting with any subcontractor(s) in connection with this Agreement, Contractor further agrees:

1) To secure from the subcontractor(s) such subcontractor(s) indication of the employee-number category applicable to the subcontractor(s); and

2) To secure from the subcontractor(s) an affidavit attesting to the subcontractor's compliance with O.C.G.A. Sec. 13-10-91 and DOL Rule 300-10-1; such affidavit being in the form attached hereto and referenced as EXHIBIT A-1; and

3) To submit such subcontractor affidavits(s) to the Owner when the subcontractor(s) is retained, but in any event, prior to the commencement of work by the subcontractor(s).

The failure of Contractor to supply the affidavit of compliance at the time of execution of this Agreement and/or the failure of Contractor to continue to satisfy the obligations of O.C.G.A. §13-10-91 and DOL Rule 300-10-1 as set forth in this Agreement during the term on the Agreement shall constitute a material breach of the contact. Upon notice of such breach Contractor shall be entitled to cure the breach within ten days, upon providing satisfactory evidence of compliance with the terms of this Agreement and State law. Should the breach not be cured, the County shall be entitled to all available remedies, including termination of the contact and damages.

END OF SECTION

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 (name of public employer) 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

_____
Name of Project

_____
Name of Public Employer

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

Executed on _____, ___, 2015 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 _____, 2015.

_____
NOTARY PUBLIC

My Commission Expires:

_____

Subcontractor Affidavit under O.C.G.A. § 13-10-91(b)(3)

By executing this affidavit, the undersigned subcontractor 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 under a contract with (name of contractor) on behalf of (name of public employer) 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 subcontractor will continue to use the federal work authorization program throughout the contract period and the undersigned subcontractor will contract for the physical performance of services in satisfaction of such contract only with sub-subcontractors who present an affidavit to the subcontractor with the information required by O.C.G.A. § 13-10-91(b). Additionally, the undersigned subcontractor will forward notice of the receipt of an affidavit from a sub-subcontractor to the contractor within five business days of receipt. If the undersigned subcontractor receives notice that a sub-subcontractor has received an affidavit from any other contracted sub-subcontractor, the undersigned subcontractor must forward, within five business days of receipt, a copy of the notice to the contractor. Subcontractor 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 Subcontractor

_____
Name of Project

_____
Name of Public Employer

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

Executed on _____, ___, 2015 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 _____, 2015.

_____
NOTARY PUBLIC

My Commission Expires:

_____

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: chemical system modifications and filter upgrades at the Crosstown Water Treatment Plant.

2. THE PROJECT

2.1. The Project for which the Work under the Contract Documents may be the whole or only a part is generally described as follows: new powdered activated carbon storage and feed system; a new chlorine dioxide storage and feed system; rehabilitation of the existing eight filters; selective demolition; yard piping for new and existing facilities; electrical system improvements to support new loads; computer-based controls associated with improvements; site development and storm water management.

3. ENGINEER

3.1. The Project has been designed by CH2M HILL (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.

4. CONTRACT TIMES

4.1. Time of the Essence: Time limits for Milestones, if any, Substantial Completion, and completion and readiness for final payment as stated in the Contract Documents are of the essence of the Contract.

4.2. Days to Achieve Substantial Completion and Final Payment:

4.2.1. The Work shall be substantially completed within 335 days from the date when the Contract Times commence to run as provided in Paragraph 2.03 of the General Conditions, and completed and ready for final payment in accordance with Paragraph 14.07 of the General Conditions within 365 days after the date when the Contract Times commence to run.

4.3. Liquidated Damages:

4.3.1. 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 12 of the General Conditions. The parties also recognize the delays, expense, and difficulties involved in proving in a legal or arbitration proceeding the actual loss suffered by Owner if the Work is not completed on time. Accordingly, instead of requiring any such proof, Owner and Contractor agree that as liquidated damages for delay (but not as a penalty) Contractor shall pay Owner $500.00 for each day that expires after the time specified herein for Substantial Completion until the Work is substantially complete

5. CONTRACT PRICE

5.1. For all Work, at the prices stated in Contractor's Bid, attached hereto as an exhibit.

5.2. 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:

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

5.2.1.1. The above lump sum amount reflects Owner's adoption of the following alternates:

5.2.1.1.1 Sodium Permanganate Fiberglass Building.

5.2.1.2. Cash allowance(s) are included in the above lump sum price and have been computed in accordance with Paragraph 11.02 of the General Conditions.

5.2.2. Unit Prices:

5.2.2.1. As provided in Paragraph 11.03 of the General Conditions, estimated quantities are not guaranteed, and determinations of actual quantities and classifications are to be made by Engineer as provided in Paragraph 9.07 of the General Conditions. Unit prices have been computed as provided in Paragraph 11.03 of the General Conditions.

5.2.2.2. For Unit Price Work, an amount equal to the sum of established unit price for each separately identified item of Unit Price Work times the estimated quantity of that item as indicated in this paragraph:

Item No.	Description	Estimated Quantity	Unit	Unit Price	Estimated Price
1.	Removal of Unsuitable Materials and Replacement with Compacted Granular Fill	100	cu yd	$_____	$_____
				TOTAL OF ESTIMATED UNIT PRICES: $_____	

6. PAYMENT PROCEDURES

6.1. Submittal and Processing of Payments: Contractor shall submit Applications for Payment in accordance with Article 14 of the General Conditions. Applications for Payment will be processed by Engineer as provided in the General Conditions.

6.2. 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 2.07 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.

6.2.1. Prior to Substantial Completion, progress payments will be made in an amount equal to the percentage indicated below 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 14.02 of the General Conditions:

6.2.1.1. 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

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

6.2.2. In lieu of retainage, provisions may be made as provided in OCGA 13-10-82, for establishing an escrow account with Owner.

6.2.3. 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 14.02.B.5 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.

6.3. Final Payment:

6.3.1. Upon final completion and acceptance of the Work in accordance with Paragraph 14.07 of the General Conditions, Owner will pay the remainder of the Contract Price as recommended by Engineer as provided in Paragraph 14.07.

7. INTEREST

7.1. Monies not paid when due as provided in Article 14 of the General Conditions shall bear interest at the rate of one-half percent per month.

8. CONTRACTOR'S REPRESENTATIONS

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

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

8.1.2. 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.

8.1.3. 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.

8.1.4. 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 4.02 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 4.06 of the Supplementary Conditions as containing reliable "technical data."

8.1.5. 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.

8.1.6. 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.

8.1.7. 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.

8.1.8. 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.

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

9. CONTRACT DOCUMENTS

9.1. Contents:

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

9.1.1.1. This Agreement.

9.1.1.2. Performance Bond.

9.1.1.3. Payment Bond.

9.1.1.4. General Conditions.

9.1.1.5. Supplementary Conditions.

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

9.1.1.7. Drawings.

9.1.1.8. Addenda.

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

9.1.2.1. Contractor's Bid.

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

9.1.3.1. Notice to Proceed.

9.1.3.2. Work Change Directives.

9.1.3.3. Change Order(s).

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

9.3. The Contract Documents may only be amended, modified, or supplemented as provided in Paragraph 3.04 of the General Conditions.

10. MISCELLANEOUS

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

10.2. 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.

10.3. 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.

10.4. Assignment of Contract:

10.4.1. 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.

10.5. Contractor's Certifications:

10.5.1. 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:

10.5.1.1. "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;

10.5.1.2. "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;

10.5.1.3. "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

10.5.1.4. "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 _____, 20__ (which is the Effective Date of the Agreement).

OWNER: Fayette County

[CORPORATE SEAL]

By: _____

Attest: _____

Title: _____

Title: _____

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.)

CONTRACTOR:_____

_____

By: _____

Title: _____

[CORPORATE SEAL]

Attest: _____

Title:_____

Address for giving notices:

_____

_____

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

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

CONTRACT

Date:
Amount:
Description (Name and Location):

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

Company:

Signature: _____(Seal)
Name and Title

SURETY

_____(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

CONTRACTOR AS PRINCIPAL

Company:

Signature: _____(Seal)
Name and Title

SURETY

_____(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 Stonewall Avenue West, Suite 204
Fayetteville, GA

CONTRACT

Date:
Amount:
Description (Name and Location):

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

Company:

Signature: _____(Seal)
Name and Title

SURETY

_____(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

CONTRACTOR AS PRINCIPAL

Company:

Signature: _____(Seal)
Name and Title

SURETY

_____(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

STANDARD GENERAL CONDITIONS OF THE CONSTRUCTION CONTRACT

Prepared by

ENGINEERS JOINT CONTRACT DOCUMENTS COMMITTEE

and

Issued and Published Jointly by

AMERICAN COUNCIL OF ENGINEERING COMPANIES

ASSOCIATED GENERAL CONTRACTORS OF AMERICA

AMERICAN SOCIETY OF CIVIL ENGINEERS

PROFESSIONAL ENGINEERS IN PRIVATE PRACTICE
A Practice Division of the
NATIONAL SOCIETY OF PROFESSIONAL ENGINEERS

Endorsed by

CONSTRUCTION SPECIFICATIONS INSTITUTE

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

STANDARD GENERAL CONDITIONS OF THE CONSTRUCTION CONTRACT

TABLE OF CONTENTS

Page

STANDARD GENERAL CONDITIONS OF THE CONSTRUCTION CONTRACT

ARTICLE 1 – DEFINITIONS AND TERMINOLOGY

1.01 *Defined Terms*

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

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

2. *Agreement*—The written instrument which is evidence of the agreement between Owner and Contractor covering the Work.

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

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

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

6. *Bidder*—The individual or entity who submits a Bid directly to Owner.

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

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

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

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

11. *Contract*—The entire and integrated written agreement between the Owner and Contractor concerning the Work. The Contract supersedes prior negotiations, representations, or agreements, whether written or oral.

12. *Contract Documents*—Those items so designated in the Agreement. Only printed or hard copies of the items listed in the Agreement are Contract Documents. Approved Shop Drawings, other Contractor submittals, and the reports and drawings of subsurface and physical conditions are not Contract Documents.

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

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

15. *Contractor*—The individual or entity with whom Owner has entered into the Agreement.

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

17. *Drawings*—That part of the Contract Documents prepared or approved by Engineer which graphically shows the scope, extent, and character of the Work to be performed by Contractor. Shop Drawings and other Contractor submittals are not Drawings as so defined.

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

19. *Engineer*—The individual or entity named as such in the Agreement.

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

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

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

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

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

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

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

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

28. *Notice to Proceed*—A written notice given by Owner to Contractor fixing the date on which the Contract Times will commence to run and on which Contractor shall start to perform the Work under the Contract Documents.

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

30. *PCBs*—Polychlorinated biphenyls.

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

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

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

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

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

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

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

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

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

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

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

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

43. *Subcontractor*—An individual or entity having a direct contract with Contractor or with any other Subcontractor for the performance of a part of the Work at the Site.

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

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

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

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

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

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

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

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

1.02 *Terminology*

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

B. *Intent of Certain Terms or Adjectives:*

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

C. *Day:*

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

D. *Defective:*

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

a. does not conform to the Contract Documents; or

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

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

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

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

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

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

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

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

ARTICLE 2 – PRELIMINARY MATTERS

2.01 *Delivery of Bonds and Evidence of Insurance*

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

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

2.02 *Copies of Documents*

A. Owner shall furnish to Contractor up to ten printed or hard copies of the Drawings and Project Manual. Additional copies will be furnished upon request at the cost of reproduction.

2.03 *Commencement of Contract Times; Notice to Proceed*

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

2.04 *Starting the Work*

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

2.05 *Before Starting Construction*

A. *Preliminary Schedules:* Within 10 days after the Effective Date of the Agreement (unless otherwise specified in the General Requirements), Contractor shall submit to Engineer for timely review:

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

2. a preliminary Schedule of Submittals; and

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

2.06 *Preconstruction Conference; Designation of Authorized Representatives*

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

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

2.07 *Initial Acceptance of Schedules*

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

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

2. Contractor's Schedule of Submittals will be acceptable to Engineer if it provides a workable arrangement for reviewing and processing the required submittals.

3. Contractor's Schedule of Values will be acceptable to Engineer as to form and substance if it provides a reasonable allocation of the Contract Price to component parts of the Work.

ARTICLE 3 – CONTRACT DOCUMENTS: INTENT, AMENDING, REUSE

3.01 *Intent*

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

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

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

3.02 *Reference Standards*

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

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

2. No provision of any such standard, specification, manual, or code, or any instruction of a Supplier, shall be effective to change the duties or responsibilities of Owner, Contractor, or Engineer, or any of their subcontractors, consultants, agents, or employees,

from those set forth in the Contract Documents. No such provision or instruction shall be effective to assign to Owner, Engineer, or any of their officers, directors, members, partners, employees, agents, consultants, or subcontractors, any duty or authority to supervise or direct the performance of the Work or any duty or authority to undertake responsibility inconsistent with the provisions of the Contract Documents.

3.03 *Reporting and Resolving Discrepancies*

A. *Reporting Discrepancies:*

1. *Contractor's Review of Contract Documents Before Starting Work*: Before undertaking each part of the Work, Contractor shall carefully study and compare the Contract Documents and check and verify pertinent figures therein and all applicable field measurements. Contractor shall promptly report in writing to Engineer any conflict, error, ambiguity, or discrepancy which Contractor discovers, or has actual knowledge of, and shall obtain a written interpretation or clarification from Engineer before proceeding with any Work affected thereby.

2. *Contractor's Review of Contract Documents During Performance of Work*: If, during the performance of the Work, Contractor discovers any conflict, error, ambiguity, or discrepancy within the Contract Documents, or between the Contract Documents and (a) any applicable Law or Regulation , (b) any standard, specification, manual, or code, or (c) any instruction of any Supplier, then Contractor shall promptly report it to Engineer in writing. Contractor shall not proceed with the Work affected thereby (except in an emergency as required by Paragraph 6.16.A) until an amendment or supplement to the Contract Documents has been issued by one of the methods indicated in Paragraph 3.04.

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

B. *Resolving Discrepancies:*

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

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

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

3.04 *Amending and Supplementing Contract Documents*

A. The Contract Documents may be amended to provide for additions, deletions, and revisions in the Work or to modify the terms and conditions thereof by either a Change Order or a Work Change Directive.

B. The requirements of the Contract Documents may be supplemented, and minor variations and deviations in the Work may be authorized, by one or more of the following ways:

1. A Field Order;

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

3. Engineer's written interpretation or clarification.

3.05 *Reuse of Documents*

A. Contractor and any Subcontractor or Supplier shall not:

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

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

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

3.06 *Electronic Data*

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

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

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

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

4.01 *Availability of Lands*

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

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

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

4.02 *Subsurface and Physical Conditions*

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

1. those reports known to Owner of explorations and tests of subsurface conditions at or contiguous to the Site; and

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

B. *Limited Reliance by Contractor on Technical Data Authorized:* Contractor may rely upon the accuracy of the "technical data" contained in such reports and drawings, but such reports and drawings are not Contract Documents. Such "technical data" is identified in the Supplementary Conditions. Except for such reliance on such "technical data," Contractor may not rely upon or make any claim against Owner or Engineer, or any of their officers, directors, members, partners, employees, agents, consultants, or subcontractors with respect to:

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

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

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

4.03 *Differing Subsurface or Physical Conditions*

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

1. is of such a nature as to establish that any "technical data" on which Contractor is entitled to rely as provided in Paragraph 4.02 is materially inaccurate; or

2. is of such a nature as to require a change in the Contract Documents; or

3. differs materially from that shown or indicated in the Contract Documents; or

4. is of an unusual nature, and differs materially from conditions ordinarily encountered and generally recognized as inherent in work of the character provided for in the Contract Documents;

5. then Contractor shall, promptly after becoming aware thereof and before further disturbing the subsurface or physical conditions or performing any Work in connection therewith (except in an emergency as required by Paragraph 6.16.A), notify Owner and Engineer in writing about such condition. Contractor shall not further disturb such condition or perform any Work in connection therewith (except as aforesaid) until receipt of written order to do so.

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

C. *Possible Price and Times Adjustments:*

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

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

b. with respect to Work that is paid for on a unit price basis, any adjustment in Contract Price will be subject to the provisions of Paragraphs 9.07 and 11.03.

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

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

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

c. Contractor failed to give the written notice as required by Paragraph 4.03.A.

3. If Owner and Contractor are unable to agree on entitlement to or on the amount or extent, if any, of any adjustment in the Contract Price or Contract Times, or both, a Claim may be made therefor as provided in Paragraph 10.05. However, neither Owner or Engineer, or any of their officers, directors, members, partners, employees, agents, consultants, or subcontractors shall be liable to Contractor for any claims, costs, losses, or damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) sustained by Contractor on or in connection with any other project or anticipated project.

4.04 *Underground Facilities*

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

1. Owner and Engineer shall not be responsible for the accuracy or completeness of any such information or data provided by others; and

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

a. reviewing and checking all such information and data;

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

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

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

B. *Not Shown or Indicated:*

1. If an Underground Facility is uncovered or revealed at or contiguous to the Site which was not shown or indicated, or not shown or indicated with reasonable accuracy in the Contract Documents, Contractor shall, promptly after becoming aware thereof and before further disturbing conditions affected thereby or performing any Work in connection therewith (except in an emergency as required by Paragraph 6.16.A), identify the owner of such Underground Facility and give written notice to that owner and to Owner and Engineer. Engineer will promptly review the Underground Facility and determine the extent, if any, to which a change is required in the Contract Documents to reflect and document the consequences of the existence or location of the Underground Facility. During such time, Contractor shall be responsible for the safety and protection of such Underground Facility.

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

4.05 *Reference Points*

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

4.06 *Hazardous Environmental Condition at Site*

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

B. *Limited Reliance by Contractor on Technical Data Authorized:* Contractor may rely upon the accuracy of the "technical data" contained in such reports and drawings, but such reports and drawings are not Contract Documents. Such "technical data" is identified in the Supplementary Conditions. Except for such reliance on such "technical data," Contractor may not rely upon or make any claim against Owner or Engineer, or any of their officers, directors, members, partners, employees, agents, consultants, or subcontractors with respect to:

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

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

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

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

D. If Contractor encounters a Hazardous Environmental Condition or if Contractor or anyone for whom Contractor is responsible creates a Hazardous

Environmental Condition, Contractor shall immediately: (i) secure or otherwise isolate such condition; (ii) stop all Work in connection with such condition and in any area affected thereby (except in an emergency as required by Paragraph 6.16.A); and (iii) notify Owner and Engineer (and promptly thereafter confirm such notice in writing). Owner shall promptly consult with Engineer concerning the necessity for Owner to retain a qualified expert to evaluate such condition or take corrective action, if any. Promptly after consulting with Engineer, Owner shall take such actions as are necessary to permit Owner to timely obtain required permits and provide Contractor the written notice required by Paragraph 4.06.E.

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

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

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

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

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

ARTICLE 5 – BONDS AND INSURANCE

5.01 *Performance, Payment, and Other Bonds*

A. Contractor shall furnish performance and payment bonds, each in an amount at least equal to the Contract Price as security for the faithful performance and payment of all of Contractor's obligations under the Contract Documents. These bonds shall remain in effect until one year after the date when final payment becomes due or until completion of the correction period specified in Paragraph 13.07, whichever is later, except as provided otherwise by Laws or Regulations or by the Contract Documents. Contractor shall also furnish such other bonds as are required by the Contract Documents.

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

authority shall show that it is effective on the date the agent or attorney-in-fact signed each bond.

C. If the surety on any bond furnished by Contractor is declared bankrupt or becomes insolvent or its right to do business is terminated in any state where any part of the Project is located or it ceases to meet the requirements of Paragraph 5.01.B, Contractor shall promptly notify Owner and Engineer and shall, within 20 days after the event giving rise to such notification, provide another bond and surety, both of which shall comply with the requirements of Paragraphs 5.01.B and 5.02.

5.02 *Licensed Sureties and Insurers*

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

5.03 *Certificates of Insurance*

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

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

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

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

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

5.04 *Contractor's Insurance*

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

1. claims under workers' compensation, disability benefits, and other similar employee benefit acts;

2. claims for damages because of bodily injury, occupational sickness or disease, or death of Contractor's employees;

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

4. claims for damages insured by reasonably available personal injury liability coverage which are sustained:

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

   b. by any other person for any other reason;

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

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

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

1. with respect to insurance required by Paragraphs 5.04.A.3 through 5.04.A.6 inclusive, be written on an occurrence basis, include as additional insureds (subject to any customary exclusion regarding professional liability) Owner and Engineer, and any other individuals or entities identified in the Supplementary Conditions, all of

whom shall be listed as additional insureds, and include coverage for the respective officers, directors, members, partners, employees, agents, consultants, and subcontractors of each and any of all such additional insureds, and the insurance afforded to these additional insureds shall provide primary coverage for all claims covered thereby;

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

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

4. contain a provision or endorsement that the coverage afforded will not be canceled, materially changed or renewal refused until at least 30 days prior written notice has been given to Owner and Contractor and to each other additional insured identified in the Supplementary Conditions to whom a certificate of insurance has been issued (and the certificates of insurance furnished by the Contractor pursuant to Paragraph 5.03 will so provide);

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

6. include completed operations coverage:

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

b. Contractor shall furnish Owner and each other additional insured identified in the Supplementary Conditions, to whom a certificate of insurance has been issued, evidence satisfactory to Owner and any such additional insured of continuation of such insurance at final payment and one year thereafter.

5.05 *Owner's Liability Insurance*

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

5.06 *Property Insurance*

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

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

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

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

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

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

6. include testing and startup; and

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

B. Owner shall purchase and maintain such equipment breakdown insurance or additional property insurance as may be required by the Supplementary Conditions or Laws and Regulations which will include the

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

C. All the policies of insurance (and the certificates or other evidence thereof) required to be purchased and maintained in accordance with this Paragraph 5.06 will contain a provision or endorsement that the coverage afforded will not be canceled or materially changed or renewal refused until at least 30 days prior written notice has been given to Owner and Contractor and to each other loss payee to whom a certificate of insurance has been issued and will contain waiver provisions in accordance with Paragraph 5.07.

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

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

5.07 *Waiver of Rights*

A. Owner and Contractor intend that all policies purchased in accordance with Paragraph 5.06 will protect Owner, Contractor, Subcontractors, and Engineer, and all other individuals or entities identified in the Supplementary Conditions as loss payees (and the officers, directors, members, partners, employees, agents, consultants, and subcontractors of each and any of them) in such policies and will provide primary coverage for all losses and damages caused by the perils or causes of loss covered thereby. All such policies shall contain provisions to the effect that in the event of payment of any loss or damage the insurers will have no rights of recovery against any of the insureds or loss payees thereunder. Owner and Contractor waive all rights against each other and their respective officers, directors, members, partners, employees, agents, consultants and subcontractors of each and any of them for all losses and damages caused by, arising out of or resulting from any of the perils or causes of loss covered by such policies and any other property insurance applicable to the Work; and, in addition, waive all such rights against Subcontractors and Engineer, and all other individuals or entities identified in the Supplementary Conditions as loss payees (and the officers, directors, members, partners, employees, agents, consultants, and subcontractors of each and any of them) under such policies for losses and damages so caused. None of the above waivers shall extend to the rights that any party making such waiver may have to the proceeds of insurance held by Owner as trustee or otherwise payable under any policy so issued.

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

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

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

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

5.08 *Receipt and Application of Insurance Proceeds*

A. Any insured loss under the policies of insurance required by Paragraph 5.06 will be adjusted with Owner and made payable to Owner as fiduciary for the loss payees, as their interests may appear, subject to the requirements of any applicable mortgage clause and of

Paragraph 5.08.B. Owner shall deposit in a separate account any money so received and shall distribute it in accordance with such agreement as the parties in interest may reach. If no other special agreement is reached, the damaged Work shall be repaired or replaced, the moneys so received applied on account thereof, and the Work and the cost thereof covered by an appropriate Change Order.

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

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

A. If either Owner or Contractor has any objection to the coverage afforded by or other provisions of the bonds or insurance required to be purchased and maintained by the other party in accordance with Article 5 on the basis of non-conformance with the Contract Documents, the objecting party shall so notify the other party in writing within 10 days after receipt of the certificates (or other evidence requested) required by Paragraph 2.01.B. Owner and Contractor shall each provide to the other such additional information in respect of insurance provided as the other may reasonably request. If either party does not purchase or maintain all of the bonds and insurance required of such party by the Contract Documents, such party shall notify the other party in writing of such failure to purchase prior to the start of the Work, or of such failure to maintain prior to any change in the required coverage. Without prejudice to any other right or remedy, the other party may elect to obtain equivalent bonds or insurance to protect such other party's interests at the expense of the party who was required to provide such coverage, and a Change Order shall be issued to adjust the Contract Price accordingly.

5.10 *Partial Utilization, Acknowledgment of Property Insurer*

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

ARTICLE 6 – CONTRACTOR'S RESPONSIBILITIES

6.01 *Supervision and Superintendence*

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

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

6.02 *Labor; Working Hours*

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

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

6.03 *Services, Materials, and Equipment*

A. Unless otherwise specified in the Contract Documents, Contractor shall provide and assume full responsibility for all services, materials, equipment, labor, transportation, construction equipment and machinery, tools, appliances, fuel, power, light, heat, telephone, water,

sanitary facilities, temporary facilities, and all other facilities and incidentals necessary for the performance, testing, start-up, and completion of the Work.

B. All materials and equipment incorporated into the Work shall be as specified or, if not specified, shall be of good quality and new, except as otherwise provided in the Contract Documents. All special warranties and guarantees required by the Specifications shall expressly run to the benefit of Owner. If required by Engineer, Contractor shall furnish satisfactory evidence (including reports of required tests) as to the source, kind, and quality of materials and equipment.

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

6.04 *Progress Schedule*

A. Contractor shall adhere to the Progress Schedule established in accordance with Paragraph 2.07 as it may be adjusted from time to time as provided below.

1. Contractor shall submit to Engineer for acceptance (to the extent indicated in Paragraph 2.07) proposed adjustments in the Progress Schedule that will not result in changing the Contract Times. Such adjustments will comply with any provisions of the General Requirements applicable thereto.

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

6.05 *Substitutes and "Or-Equals"*

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

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

a. in the exercise of reasonable judgment Engineer determines that:

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

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

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

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

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

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

2. *Substitute Items*:

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

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

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

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

1) shall certify that the proposed substitute item will:

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

b) be similar in substance to that specified, and

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

2) will state:

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

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

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

3) will identify:

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

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

4) shall contain an itemized estimate of all costs or credits that will result directly or indirectly from use of such substitute item, including costs of redesign and claims of other contractors affected by any resulting change.

B. *Substitute Construction Methods or Procedures:* If a specific means, method, technique, sequence, or procedure of construction is expressly required by the Contract Documents, Contractor may furnish or utilize a substitute means, method, technique, sequence, or procedure of construction approved by Engineer. Contractor shall submit sufficient information to allow Engineer, in Engineer's sole discretion, to determine that the substitute proposed is equivalent to that expressly called for by the Contract Documents. The requirements for review by Engineer will be similar to those provided in Paragraph 6.05.A.2.

C. *Engineer's Evaluation:* Engineer will be allowed a reasonable time within which to evaluate each proposal or submittal made pursuant to Paragraphs 6.05.A and 6.05.B. Engineer may require Contractor to furnish additional data about the proposed substitute item. Engineer will be the sole judge of acceptability. No "or equal" or substitute will be ordered, installed or utilized until Engineer's review is complete, which will be evidenced by a Change Order in the case of a substitute and an approved Shop Drawing for an "or equal." Engineer will advise Contractor in writing of any negative determination.

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

E. *Engineer's Cost Reimbursement*: Engineer will record Engineer's costs in evaluating a substitute proposed or submitted by Contractor pursuant to Paragraphs 6.05.A.2 and 6.05.B. Whether or not Engineer approves a substitute so proposed or submitted by Contractor, Contractor shall reimburse Owner for the reasonable charges of Engineer for evaluating each such proposed substitute. Contractor shall also reimburse Owner for the reasonable charges of Engineer for making changes in the Contract Documents (or in the provisions of any other direct contract with Owner) resulting from the acceptance of each proposed substitute.

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

6.06 *Concerning Subcontractors, Suppliers, and Others*

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

B. If the Supplementary Conditions require the identity of certain Subcontractors, Suppliers, or other individuals or entities to be submitted to Owner in advance for acceptance by Owner by a specified date prior to the Effective Date of the Agreement, and if Contractor has submitted a list thereof in accordance with the Supplementary Conditions, Owner's acceptance (either in writing or by failing to make written objection thereto by the date indicated for acceptance or objection in the Bidding Documents or the Contract Documents) of any such Subcontractor, Supplier, or other individual or entity so identified may be revoked on the basis of reasonable objection after due investigation. Contractor shall submit an acceptable replacement for the rejected Subcontractor, Supplier, or other individual or entity, and the Contract Price will be adjusted by the difference in the cost occasioned by such replacement, and an appropriate Change Order will be issued. No acceptance by Owner of any such Subcontractor, Supplier, or other individual or entity, whether initially or as a replacement, shall constitute a waiver of any right of Owner or Engineer to reject defective Work.

C. Contractor shall be fully responsible to Owner and Engineer for all acts and omissions of the Subcontractors, Suppliers, and other individuals or entities performing or furnishing any of the Work just as Contractor is responsible for Contractor's own acts and omissions. Nothing in the Contract Documents:

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

2. shall create any obligation on the part of Owner or Engineer to pay or to see to the payment of any moneys due any such Subcontractor, Supplier, or other individual or entity except as may otherwise be required by Laws and Regulations.

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

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

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

G. All Work performed for Contractor by a Subcontractor or Supplier will be pursuant to an appropriate agreement between Contractor and the Subcontractor or Supplier which specifically binds the Subcontractor or Supplier to the applicable terms and conditions of the Contract Documents for the benefit of Owner and Engineer. Whenever any such agreement is with a Subcontractor or Supplier who is listed as a loss payee on the property insurance provided in Paragraph 5.06, the agreement between the Contractor and the Subcontractor or Supplier will contain provisions whereby the Subcontractor or Supplier waives all rights against Owner, Contractor, Engineer, and all other individuals or entities identified in the Supplementary Conditions to be listed as insureds or loss payees (and the officers, directors, members, partners, employees, agents, consultants, and subcontractors of each and any of them) for all losses and damages caused by, arising out of, relating to, or resulting from any of the perils or causes of loss covered by such policies and any other property insurance applicable to the Work. If the insurers on any such policies require separate waiver forms to be signed by any Subcontractor or Supplier, Contractor will obtain the same.

6.07 *Patent Fees and Royalties*

A. Contractor shall pay all license fees and royalties and assume all costs incident to the use in the performance of the Work or the incorporation in the Work of any invention, design, process, product, or device which is the subject of patent rights or copyrights held by others. If a particular invention, design, process, product, or device is specified in the Contract Documents for use in the performance of the Work and if, to the actual knowledge of Owner or Engineer, its use is subject to patent rights or copyrights calling for the payment of any license fee or royalty to others, the existence of such rights shall be disclosed by Owner in the Contract Documents.

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

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

6.08 *Permits*

A. Unless otherwise provided in the Supplementary Conditions, Contractor shall obtain and pay for all construction permits and licenses. Owner shall assist Contractor, when necessary, in obtaining such permits and licenses. Contractor shall pay all governmental charges and inspection fees necessary for the prosecution of the Work which are applicable at the time of opening of Bids, or, if there are no Bids, on the Effective Date of the Agreement. Owner shall pay all charges of utility owners for connections for providing permanent service to the Work.

6.09 *Laws and Regulations*

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

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

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

6.10 *Taxes*

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

6.11 *Use of Site and Other Areas*

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

1. Contractor shall confine construction equipment, the storage of materials and equipment, and the operations of workers to the Site and other areas permitted by Laws and Regulations, and shall not unreasonably encumber the Site and other areas with construction equipment or other materials or equipment. Contractor shall assume full responsibility for any damage to any such land or area, or to the owner or occupant thereof, or of any adjacent land or areas resulting from the performance of the Work.

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

3. To the fullest extent permitted by Laws and Regulations, Contractor shall indemnify and hold harmless Owner and Engineer, and the officers, directors, members,

partners, employees, agents, consultants and subcontractors of each and any of them from and against all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to any claim or action, legal or equitable, brought by any such owner or occupant against Owner, Engineer, or any other party indemnified hereunder to the extent caused by or based upon Contractor's performance of the Work.

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

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

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

6.12 *Record Documents*

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

6.13 *Safety and Protection*

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

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

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

3. other property at the Site or adjacent thereto, including trees, shrubs, lawns, walks, pavements, roadways, structures, utilities, and Underground Facilities not designated for removal, relocation, or replacement in the course of construction.

B. Contractor shall comply with all applicable Laws and Regulations relating to the safety of persons or property, or to the protection of persons or property from damage, injury, or loss; and shall erect and maintain all necessary safeguards for such safety and protection. Contractor shall notify owners of adjacent property and of Underground Facilities and other utility owners when prosecution of the Work may affect them, and shall cooperate with them in the protection, removal, relocation, and replacement of their property.

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

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

E. All damage, injury, or loss to any property referred to in Paragraph 6.13.A.2 or 6.13.A.3 caused, directly or indirectly, in whole or in part, by Contractor, any Subcontractor, Supplier, or any other individual or entity directly or indirectly employed by any of them to perform any of the Work, or anyone for whose acts any of them may be liable, shall be remedied by Contractor (except damage or loss attributable to the fault of Drawings or Specifications or to the acts or omissions of Owner or Engineer or anyone employed by any of them, or anyone for whose acts any of them may be liable, and not attributable, directly or indirectly, in whole or in part, to the fault or negligence of Contractor or any Subcontractor, Supplier, or other individual or entity directly or indirectly employed by any of them).

F. Contractor's duties and responsibilities for safety and for protection of the Work shall continue until such time as all the Work is completed and Engineer has issued a notice to Owner and Contractor in accordance with Paragraph 14.07.B that the Work is acceptable (except as otherwise expressly provided in connection with Substantial Completion).

6.14 *Safety Representative*

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

6.15 *Hazard Communication Programs*

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

6.16 *Emergencies*

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

6.17 *Shop Drawings and Samples*

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

1. *Shop Drawings:*

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

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

2. *Samples:*

a. Submit number of Samples specified in the Specifications.

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

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

C. *Submittal Procedures*:

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

a. reviewed and coordinated each Shop Drawing or Sample with other Shop Drawings and Samples and with the requirements of the Work and the Contract Documents;

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

c. determined and verified the suitability of all materials offered with respect to the indicated application, fabrication, shipping, handling, storage, assembly, and installation pertaining to the performance of the Work; and

d. determined and verified all information relative to Contractor's responsibilities for means, methods, techniques, sequences, and

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

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

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

D. *Engineer's Review:*

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

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

3. Engineer's review and approval shall not relieve Contractor from responsibility for any variation from the requirements of the Contract Documents unless Contractor has complied with the requirements of Paragraph 6.17.C.3 and Engineer has given written approval of each such variation by specific written notation thereof incorporated in or accompanying the Shop Drawing or Sample. Engineer's review and approval shall not relieve Contractor from responsibility for complying with the requirements of Paragraph 6.17.C.1.

E. *Resubmittal Procedures:*

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

6.18 *Continuing the Work*

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

6.19 *Contractor's General Warranty and Guarantee*

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

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

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

2. normal wear and tear under normal usage.

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

1. observations by Engineer;

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

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

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

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

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

7. any correction of defective Work by Owner.

6.20 *Indemnification*

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

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

C. The indemnification obligations of Contractor under Paragraph 6.20.A shall not extend to the liability of Engineer and Engineer's officers, directors, members, partners, employees, agents, consultants and subcontractors arising out of:

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

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

6.21 *Delegation of Professional Design Services*

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

B. If professional design services or certifications by a design professional related to systems, materials or equipment are specifically required of Contractor by the Contract Documents, Owner and Engineer will specify all performance and design criteria that such services must satisfy. Contractor shall cause such services or certifications to be provided by a properly licensed professional, whose signature and seal shall appear on all drawings, calculations, specifications, certifications, Shop Drawings and other submittals prepared by such professional. Shop Drawings and other submittals related to the Work designed or certified by such professional, if prepared by others, shall bear such professional's written approval when submitted to Engineer.

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

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

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

ARTICLE 7 – OTHER WORK AT THE SITE

7.01 *Related Work at Site*

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

1. written notice thereof will be given to Contractor prior to starting any such other work; and

2. if Owner and Contractor are unable to agree on entitlement to or on the amount or extent, if any, of any adjustment in the Contract Price or Contract Times that should be allowed as a result of such other work, a Claim may be made therefor as provided in Paragraph 10.05.

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

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

7.02 *Coordination*

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

1. the individual or entity who will have authority and responsibility for coordination of the activities among the various contractors will be identified;

2. the specific matters to be covered by such authority and responsibility will be itemized; and

3. the extent of such authority and responsibilities will be provided.

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

7.03 *Legal Relationships*

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

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

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

ARTICLE 8 – OWNER'S RESPONSIBILITIES

8.01 *Communications to Contractor*

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

8.02 *Replacement of Engineer*

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

8.03 *Furnish Data*

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

8.04 *Pay When Due*

A. Owner shall make payments to Contractor when they are due as provided in Paragraphs 14.02.C and 14.07.C.

8.05 *Lands and Easements; Reports and Tests*

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

8.06 *Insurance*

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

8.07 *Change Orders*

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

8.08 *Inspections, Tests, and Approvals*

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

8.09 *Limitations on Owner's Responsibilities*

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

8.10 *Undisclosed Hazardous Environmental Condition*

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

8.11 *Evidence of Financial Arrangements*

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

8.12 *Compliance with Safety Program*

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

ARTICLE 9 – ENGINEER'S STATUS DURING CONSTRUCTION

9.01 *Owner's Representative*

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

9.02 *Visits to Site*

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

B. Engineer's visits and observations are subject to all the limitations on Engineer's authority and responsibility set forth in Paragraph 9.09. Particularly, but

without limitation, during or as a result of Engineer's visits or observations of Contractor's Work, Engineer will not supervise, direct, control, or have authority over or be responsible for Contractor's means, methods, techniques, sequences, or procedures of construction, or the safety precautions and programs incident thereto, or for any failure of Contractor to comply with Laws and Regulations applicable to the performance of the Work.

9.03 *Project Representative*

A. If Owner and Engineer agree, Engineer will furnish a Resident Project Representative to assist Engineer in providing more extensive observation of the Work. The authority and responsibilities of any such Resident Project Representative and assistants will be as provided in the Supplementary Conditions, and limitations on the responsibilities thereof will be as provided in Paragraph 9.09. If Owner designates another representative or agent to represent Owner at the Site who is not Engineer's consultant, agent or employee, the responsibilities and authority and limitations thereon of such other individual or entity will be as provided in the Supplementary Conditions.

9.04 *Authorized Variations in Work*

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

9.05 *Rejecting Defective Work*

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

9.06 *Shop Drawings, Change Orders and Payments*

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

B. In connection with Engineer's authority, and limitations thereof, as to design calculations and design drawings submitted in response to a delegation of professional design services, if any, see Paragraph 6.21.

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

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

9.07 *Determinations for Unit Price Work*

A. Engineer will determine the actual quantities and classifications of Unit Price Work performed by Contractor. Engineer will review with Contractor the Engineer's preliminary determinations on such matters before rendering a written decision thereon (by recommendation of an Application for Payment or otherwise). Engineer's written decision thereon will be final and binding (except as modified by Engineer to reflect changed factual conditions or more accurate data) upon Owner and Contractor, subject to the provisions of Paragraph 10.05.

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

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

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

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

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

9.09 *Limitations on Engineer's Authority and Responsibilities*

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

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

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

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

E. The limitations upon authority and responsibility set forth in this Paragraph 9.09 shall also apply to the Resident Project Representative, if any, and assistants, if any.

9.10 *Compliance with Safety Program*

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

ARTICLE 10 – CHANGES IN THE WORK; CLAIMS

10.01 *Authorized Changes in the Work*

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

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

10.02 *Unauthorized Changes in the Work*

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

10.03 *Execution of Change Orders*

A. Owner and Contractor shall execute appropriate Change Orders recommended by Engineer covering:

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

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

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

10.04 *Notification to Surety*

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

10.05 *Claims*

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

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

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

1. deny the Claim in whole or in part;

2. approve the Claim; or

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

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

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

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

ARTICLE 11 – COST OF THE WORK; ALLOWANCES; UNIT PRICE WORK

11.01 *Cost of the Work*

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

1. Payroll costs for employees in the direct employ of Contractor in the performance of the Work under schedules of job classifications agreed upon by Owner and Contractor. Such employees shall include,

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

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

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

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

5. Supplemental costs including the following:

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

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

c. Rentals of all construction equipment and machinery, and the parts thereof whether rented from Contractor or others in accordance with rental agreements approved by Owner with the advice of Engineer, and the costs of transportation, loading, unloading, assembly, dismantling, and removal thereof. All such costs shall be in accordance with the terms of said rental agreements. The rental of any such equipment, machinery, or parts shall cease when the use thereof is no longer necessary for the Work.

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

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

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

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

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

i. The costs of premiums for all bonds and insurance Contractor is required by the Contract Documents to purchase and maintain.

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

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

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

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

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

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

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

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

11.02 *Allowances*

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

B. *Cash Allowances:*

1. Contractor agrees that:

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

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

C. *Contingency Allowance:*

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

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

11.03 *Unit Price Work*

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

estimated quantity of each item as indicated in the Agreement.

B. The estimated quantities of items of Unit Price Work are not guaranteed and are solely for the purpose of comparison of Bids and determining an initial Contract Price. Determinations of the actual quantities and classifications of Unit Price Work performed by Contractor will be made by Engineer subject to the provisions of Paragraph 9.07.

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

D. Owner or Contractor may make a Claim for an adjustment in the Contract Price in accordance with Paragraph 10.05 if:

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

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

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

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

12.01 *Change of Contract Price*

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

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

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

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

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

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

1. a mutually acceptable fixed fee; or

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

a. for costs incurred under Paragraphs 11.01.A.1 and 11.01.A.2, the Contractor's fee shall be 15 percent;

b. for costs incurred under Paragraph 11.01.A.3, the Contractor's fee shall be five percent;

c. where one or more tiers of subcontracts are on the basis of Cost of the Work plus a fee and no fixed fee is agreed upon, the intent of Paragraphs 12.01.C.2.a and 12.01.C.2.b is that the Subcontractor who actually performs the Work, at whatever tier, will be paid a fee of 15 percent of the costs incurred by such Subcontractor under Paragraphs 11.01.A.1 and 11.01.A.2 and that any higher tier Subcontractor and Contractor will each be paid a fee of five percent of the amount paid to the next lower tier Subcontractor;

d. no fee shall be payable on the basis of costs itemized under Paragraphs 11.01.A.4, 11.01.A.5, and 11.01.B;

e. the amount of credit to be allowed by Contractor to Owner for any change which results in a net decrease in cost will be the amount of the actual net decrease in cost plus a deduction in Contractor's fee by an amount equal to five percent of such net decrease; and

f. when both additions and credits are involved in any one change, the adjustment in Contractor's fee shall be computed on the basis of the net change in accordance with Paragraphs 12.01.C.2.a through 12.01.C.2.e, inclusive.

12.02 *Change of Contract Times*

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

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

12.03 *Delays*

A. Where Contractor is prevented from completing any part of the Work within the Contract Times due to delay beyond the control of Contractor, the Contract Times will be extended in an amount equal to the time lost due to such delay if a Claim is made therefor as provided in Paragraph 12.02.A. Delays beyond the control of Contractor shall include, but not be limited to, acts or neglect by Owner, acts or neglect of utility owners or other contractors performing other work as contemplated by Article 7, fires, floods, epidemics, abnormal weather conditions, or acts of God.

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

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

D. Owner, Engineer, and their officers, directors, members, partners, employees, agents, consultants, or subcontractors shall not be liable to Contractor for any claims, costs, losses, or damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) sustained by Contractor on or in connection with any other project or anticipated project.

E. Contractor shall not be entitled to an adjustment in Contract Price or Contract Times for delays within the control of Contractor. Delays attributable to and within the control of a Subcontractor or Supplier shall be deemed to be delays within the control of Contractor.

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

13.01 *Notice of Defects*

A. Prompt notice of all defective Work of which Owner or Engineer has actual knowledge will be given to Contractor. Defective Work may be rejected, corrected, or accepted as provided in this Article 13.

13.02 *Access to Work*

A. Owner, Engineer, their consultants and other representatives and personnel of Owner, independent testing laboratories, and governmental agencies with jurisdictional interests will have access to the Site and the Work at reasonable times for their observation, inspection, and testing. Contractor shall provide them proper and safe conditions for such access and advise them of Contractor's safety procedures and programs so that they may comply therewith as applicable.

13.03 *Tests and Inspections*

A. Contractor shall give Engineer timely notice of readiness of the Work for all required inspections, tests, or approvals and shall cooperate with inspection and testing personnel to facilitate required inspections or tests.

B. Owner shall employ and pay for the services of an independent testing laboratory to perform all inspections, tests, or approvals required by the Contract Documents except:

1. for inspections, tests, or approvals covered by Paragraphs 13.03.C and 13.03.D below;

2. that costs incurred in connection with tests or inspections conducted pursuant to Paragraph 13.04.B shall be paid as provided in Paragraph 13.04.C; and

3. as otherwise specifically provided in the Contract Documents.

C. If Laws or Regulations of any public body having jurisdiction require any Work (or part thereof) specifically to be inspected, tested, or approved by an employee or other representative of such public body, Contractor shall assume full responsibility for arranging and obtaining such inspections, tests, or approvals, pay all costs in connection therewith, and furnish Engineer the required certificates of inspection or approval.

D. Contractor shall be responsible for arranging and obtaining and shall pay all costs in connection with any inspections, tests, or approvals required for Owner's and Engineer's acceptance of materials or equipment to be incorporated in the Work; or acceptance of materials, mix designs, or equipment submitted for approval prior to Contractor's purchase thereof for incorporation in the Work. Such inspections, tests, or approvals shall be performed by organizations acceptable to Owner and Engineer.

E. If any Work (or the work of others) that is to be inspected, tested, or approved is covered by Contractor without written concurrence of Engineer, Contractor shall, if requested by Engineer, uncover such Work for observation.

F. Uncovering Work as provided in Paragraph 13.03.E shall be at Contractor's expense unless Contractor has given Engineer timely notice of Contractor's intention to cover the same and Engineer has not acted with reasonable promptness in response to such notice.

13.04 *Uncovering Work*

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

B. If Engineer considers it necessary or advisable that covered Work be observed by Engineer or inspected or tested by others, Contractor, at Engineer's request, shall uncover, expose, or otherwise make available for observation, inspection, or testing as Engineer may require, that portion of the Work in question, furnishing all necessary labor, material, and equipment.

C. If it is found that the uncovered Work is defective, Contractor shall pay all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to such uncovering, exposure, observation, inspection, and testing, and of satisfactory replacement or reconstruction (including but not limited to all costs of repair or replacement of work of others); and Owner shall be entitled to an appropriate decrease in the Contract Price. If the parties are unable to agree as to the amount thereof, Owner may make a Claim therefor as provided in Paragraph 10.05.

D. If the uncovered Work is not found to be defective, Contractor shall be allowed an increase in the Contract Price or an extension of the Contract Times, or both, directly attributable to such uncovering, exposure, observation, inspection, testing, replacement, and reconstruction. If the parties are unable to agree as to the amount or extent thereof, Contractor may make a Claim therefor as provided in Paragraph 10.05.

13.05 *Owner May Stop the Work*

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

13.06 *Correction or Removal of Defective Work*

A. Promptly after receipt of written notice, Contractor shall correct all defective Work, whether or not fabricated, installed, or completed, or, if the Work has been rejected by Engineer, remove it from the Project and replace it with Work that is not defective. Contractor shall pay all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to such correction or removal (including but not limited to all costs of repair or replacement of work of others).

B. When correcting defective Work under the terms of this Paragraph 13.06 or Paragraph 13.07, Contractor shall take no action that would void or otherwise

impair Owner's special warranty and guarantee, if any, on said Work.

13.07 *Correction Period*

A. If within one year after the date of Substantial Completion (or such longer period of time as may be prescribed by the terms of any applicable special guarantee required by the Contract Documents) or by any specific provision of the Contract Documents, any Work is found to be defective, or if the repair of any damages to the land or areas made available for Contractor's use by Owner or permitted by Laws and Regulations as contemplated in Paragraph 6.11.A is found to be defective, Contractor shall promptly, without cost to Owner and in accordance with Owner's written instructions:

1. repair such defective land or areas; or

2. correct such defective Work; or

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

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

B. If Contractor does not promptly comply with the terms of Owner's written instructions, or in an emergency where delay would cause serious risk of loss or damage, Owner may have the defective Work corrected or repaired or may have the rejected Work removed and replaced. All claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to such correction or repair or such removal and replacement (including but not limited to all costs of repair or replacement of work of others) will be paid by Contractor.

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

D. Where defective Work (and damage to other Work resulting therefrom) has been corrected or removed and replaced under this Paragraph 13.07, the correction period hereunder with respect to such Work will be extended for an additional period of one year after such correction or removal and replacement has been satisfactorily completed.

E. Contractor's obligations under this Paragraph 13.07 are in addition to any other obligation or warranty. The provisions of this Paragraph 13.07 shall not be construed as a substitute for, or a waiver of, the provisions of any applicable statute of limitation or repose.

13.08 *Acceptance of Defective Work*

A. If, instead of requiring correction or removal and replacement of defective Work, Owner (and, prior to Engineer's recommendation of final payment, Engineer) prefers to accept it, Owner may do so. Contractor shall pay all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) attributable to Owner's evaluation of and determination to accept such defective Work (such costs to be approved by Engineer as to reasonableness) and for the diminished value of the Work to the extent not otherwise paid by Contractor pursuant to this sentence. If any such acceptance occurs prior to Engineer's recommendation of final payment, a Change Order will be issued incorporating the necessary revisions in the Contract Documents with respect to the Work, and Owner shall be entitled to an appropriate decrease in the Contract Price, reflecting the diminished value of Work so accepted. If the parties are unable to agree as to the amount thereof, Owner may make a Claim therefor as provided in Paragraph 10.05. If the acceptance occurs after such recommendation, an appropriate amount will be paid by Contractor to Owner.

13.09 *Owner May Correct Defective Work*

A. If Contractor fails within a reasonable time after written notice from Engineer to correct defective Work, or to remove and replace rejected Work as required by Engineer in accordance with Paragraph 13.06.A, or if Contractor fails to perform the Work in accordance with the Contract Documents, or if Contractor fails to comply with any other provision of the Contract Documents, Owner may, after seven days written notice to Contractor, correct, or remedy any such deficiency.

B. In exercising the rights and remedies under this Paragraph 13.09, Owner shall proceed expeditiously. In connection with such corrective or remedial action, Owner may exclude Contractor from all or part of the Site, take possession of all or part of the Work and suspend Contractor's services related thereto, take possession of Contractor's tools, appliances, construction equipment and machinery at the Site, and incorporate in the Work all

materials and equipment stored at the Site or for which Owner has paid Contractor but which are stored elsewhere. Contractor shall allow Owner, Owner's representatives, agents and employees, Owner's other contractors, and Engineer and Engineer's consultants access to the Site to enable Owner to exercise the rights and remedies under this Paragraph.

C. All claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) incurred or sustained by Owner in exercising the rights and remedies under this Paragraph 13.09 will be charged against Contractor, and a Change Order will be issued incorporating the necessary revisions in the Contract Documents with respect to the Work; and Owner shall be entitled to an appropriate decrease in the Contract Price. If the parties are unable to agree as to the amount of the adjustment, Owner may make a Claim therefor as provided in Paragraph 10.05. Such claims, costs, losses and damages will include but not be limited to all costs of repair, or replacement of work of others destroyed or damaged by correction, removal, or replacement of Contractor's defective Work.

D. Contractor shall not be allowed an extension of the Contract Times because of any delay in the performance of the Work attributable to the exercise by Owner of Owner's rights and remedies under this Paragraph 13.09.

ARTICLE 14 – PAYMENTS TO CONTRACTOR AND COMPLETION

14.01 *Schedule of Values*

A. The Schedule of Values established as provided in Paragraph 2.07.A will serve as the basis for progress payments and will be incorporated into a form of Application for Payment acceptable to Engineer. Progress payments on account of Unit Price Work will be based on the number of units completed.

14.02 *Progress Payments*

A. *Applications for Payments:*

1. At least 20 days before the date established in the Agreement for each progress payment (but not more often than once a month), Contractor shall submit to Engineer for review an Application for Payment filled out and signed by Contractor covering the Work completed as of the date of the Application and accompanied by such supporting documentation as is required by the Contract Documents. If payment is requested on the basis of materials and equipment not incorporated in the Work but delivered and suitably stored at the Site or at another location agreed to in writing, the Application for Payment shall also be accompanied by a bill of sale, invoice, or other documentation warranting that Owner has received the materials and equipment free and clear of all Liens and evidence that the materials and equipment are covered by appropriate property insurance or other arrangements to protect Owner's interest therein, all of which must be satisfactory to Owner.

2. Beginning with the second Application for Payment, each Application shall include an affidavit of Contractor stating that all previous progress payments received on account of the Work have been applied on account to discharge Contractor's legitimate obligations associated with prior Applications for Payment.

3. The amount of retainage with respect to progress payments will be as stipulated in the Agreement.

B. *Review of Applications:*

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

2. Engineer's recommendation of any payment requested in an Application for Payment will constitute a representation by Engineer to Owner, based on Engineer's observations of the executed Work as an experienced and qualified design professional, and on Engineer's review of the Application for Payment and the accompanying data and schedules, that to the best of Engineer's knowledge, information and belief:

a. the Work has progressed to the point indicated;

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

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

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

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

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

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

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

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

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

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

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

5. Engineer may refuse to recommend the whole or any part of any payment if, in Engineer's opinion, it would be incorrect to make the representations to Owner stated in Paragraph 14.02.B.2. Engineer may also refuse to recommend any such payment or, because of subsequently discovered evidence or the results of subsequent inspections or tests, revise or revoke any such payment recommendation previously made, to such extent as may be necessary in Engineer's opinion to protect Owner from loss because:

a. the Work is defective, or completed Work has been damaged, requiring correction or replacement;

b. the Contract Price has been reduced by Change Orders;

c. Owner has been required to correct defective Work or complete Work in accordance with Paragraph 13.09; or

d. Engineer has actual knowledge of the occurrence of any of the events enumerated in Paragraph 15.02.A.

C. *Payment Becomes Due:*

1. Ten days after presentation of the Application for Payment to Owner with Engineer's recommendation, the amount recommended will (subject to the provisions of Paragraph 14.02.D) become due, and when due will be paid by Owner to Contractor.

D. *Reduction in Payment:*

1. Owner may refuse to make payment of the full amount recommended by Engineer because:

a. claims have been made against Owner on account of Contractor's performance or furnishing of the Work;

b. Liens have been filed in connection with the Work, except where Contractor has delivered a specific bond satisfactory to Owner to secure the satisfaction and discharge of such Liens;

c. there are other items entitling Owner to a set-off against the amount recommended; or

d. Owner has actual knowledge of the occurrence of any of the events enumerated in Paragraphs 14.02.B.5.a through 14.02.B.5.c or Paragraph 15.02.A.

2. If Owner refuses to make payment of the full amount recommended by Engineer, Owner will give Contractor immediate written notice (with a copy to

Engineer) stating the reasons for such action and promptly pay Contractor any amount remaining after deduction of the amount so withheld. Owner shall promptly pay Contractor the amount so withheld, or any adjustment thereto agreed to by Owner and Contractor, when Contractor remedies the reasons for such action.

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

14.03 *Contractor's Warranty of Title*

A. Contractor warrants and guarantees that title to all Work, materials, and equipment covered by any Application for Payment, whether incorporated in the Project or not, will pass to Owner no later than the time of payment free and clear of all Liens.

14.04 *Substantial Completion*

A. When Contractor considers the entire Work ready for its intended use Contractor shall notify Owner and Engineer in writing that the entire Work is substantially complete (except for items specifically listed by Contractor as incomplete) and request that Engineer issue a certificate of Substantial Completion.

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

C. If Engineer considers the Work substantially complete, Engineer will deliver to Owner a tentative certificate of Substantial Completion which shall fix the date of Substantial Completion. There shall be attached to the certificate a tentative list of items to be completed or corrected before final payment. Owner shall have seven days after receipt of the tentative certificate during which to make written objection to Engineer as to any provisions of the certificate or attached list. If, after considering such objections, Engineer concludes that the Work is not substantially complete, Engineer will, within 14 days after submission of the tentative certificate to Owner, notify Contractor in writing, stating the reasons therefor. If, after consideration of Owner's objections, Engineer considers the Work substantially complete, Engineer will, within said 14 days, execute and deliver to Owner and Contractor a definitive certificate of Substantial Completion (with a revised tentative list of items to be completed or corrected) reflecting such changes from the tentative certificate as Engineer believes justified after consideration of any objections from Owner.

D. At the time of delivery of the tentative certificate of Substantial Completion, Engineer will deliver to Owner and Contractor a written recommendation as to division of responsibilities pending final payment between Owner and Contractor with respect to security, operation, safety, and protection of the Work, maintenance, heat, utilities, insurance, and warranties and guarantees. Unless Owner and Contractor agree otherwise in writing and so inform Engineer in writing prior to Engineer's issuing the definitive certificate of Substantial Completion, Engineer's aforesaid recommendation will be binding on Owner and Contractor until final payment.

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

14.05 *Partial Utilization*

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

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

2. Contractor at any time may notify Owner and Engineer in writing that Contractor considers any such part of the Work ready for its intended use and substantially complete and request Engineer to issue a certificate of Substantial Completion for that part of the Work.

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

Owner and Contractor in writing giving the reasons therefor. If Engineer considers that part of the Work to be substantially complete, the provisions of Paragraph 14.04 will apply with respect to certification of Substantial Completion of that part of the Work and the division of responsibility in respect thereof and access thereto.

4. No use or occupancy or separate operation of part of the Work may occur prior to compliance with the requirements of Paragraph 5.10 regarding property insurance.

14.06 *Final Inspection*

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

14.07 *Final Payment*

A. *Application for Payment:*

1. After Contractor has, in the opinion of Engineer, satisfactorily completed all corrections identified during the final inspection and has delivered, in accordance with the Contract Documents, all maintenance and operating instructions, schedules, guarantees, bonds, certificates or other evidence of insurance, certificates of inspection, marked-up record documents (as provided in Paragraph 6.12), and other documents, Contractor may make application for final payment following the procedure for progress payments.

2. The final Application for Payment shall be accompanied (except as previously delivered) by:

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

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

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

d. complete and legally effective releases or waivers (satisfactory to Owner) of all Lien rights arising out of or Liens filed in connection with the Work.

3. In lieu of the releases or waivers of Liens specified in Paragraph 14.07.A.2 and as approved by Owner, Contractor may furnish receipts or releases in full and an affidavit of Contractor that: (i) the releases and receipts include all labor, services, material, and equipment for which a Lien could be filed; and (ii) all payrolls, material and equipment bills, and other indebtedness connected with the Work for which Owner might in any way be responsible, or which might in any way result in liens or other burdens on Owner's property, have been paid or otherwise satisfied. If any Subcontractor or Supplier fails to furnish such a release or receipt in full, Contractor may furnish a bond or other collateral satisfactory to Owner to indemnify Owner against any Lien.

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

1. If, on the basis of Engineer's observation of the Work during construction and final inspection, and Engineer's review of the final Application for Payment and accompanying documentation as required by the Contract Documents, Engineer is satisfied that the Work has been completed and Contractor's other obligations under the Contract Documents have been fulfilled, Engineer will, within ten days after receipt of the final Application for Payment, indicate in writing Engineer's recommendation of payment and present the Application for Payment to Owner for payment. At the same time Engineer will also give written notice to Owner and Contractor that the Work is acceptable subject to the provisions of Paragraph 14.09. Otherwise, Engineer will return the Application for Payment to Contractor, indicating in writing the reasons for refusing to recommend final payment, in which case Contractor shall make the necessary corrections and resubmit the Application for Payment.

C. *Payment Becomes Due:*

1. Thirty days after the presentation to Owner of the Application for Payment and accompanying documentation, the amount recommended by Engineer, less any sum Owner is entitled to set off against Engineer's recommendation, including but not limited to liquidated damages, will become due and will be paid by Owner to Contractor.

14.08 *Final Completion Delayed*

A. If, through no fault of Contractor, final completion of the Work is significantly delayed, and if Engineer so confirms, Owner shall, upon receipt of

Contractor's final Application for Payment (for Work fully completed and accepted) and recommendation of Engineer, and without terminating the Contract, make payment of the balance due for that portion of the Work fully completed and accepted. If the remaining balance to be held by Owner for Work not fully completed or corrected is less than the retainage stipulated in the Agreement, and if bonds have been furnished as required in Paragraph 5.01, the written consent of the surety to the payment of the balance due for that portion of the Work fully completed and accepted shall be submitted by Contractor to Engineer with the Application for such payment. Such payment shall be made under the terms and conditions governing final payment, except that it shall not constitute a waiver of Claims.

14.09 *Waiver of Claims*

A. The making and acceptance of final payment will constitute:

1. a waiver of all Claims by Owner against Contractor, except Claims arising from unsettled Liens, from defective Work appearing after final inspection pursuant to Paragraph 14.06, from failure to comply with the Contract Documents or the terms of any special guarantees specified therein, or from Contractor's continuing obligations under the Contract Documents; and

2. a waiver of all Claims by Contractor against Owner other than those previously made in accordance with the requirements herein and expressly acknowledged by Owner in writing as still unsettled.

ARTICLE 15 – SUSPENSION OF WORK AND TERMINATION

15.01 *Owner May Suspend Work*

A. At any time and without cause, Owner may suspend the Work or any portion thereof for a period of not more than 90 consecutive days by notice in writing to Contractor and Engineer which will fix the date on which Work will be resumed. Contractor shall resume the Work on the date so fixed. Contractor shall be granted an adjustment in the Contract Price or an extension of the Contract Times, or both, directly attributable to any such suspension if Contractor makes a Claim therefor as provided in Paragraph 10.05.

15.02 *Owner May Terminate for Cause*

A. The occurrence of any one or more of the following events will justify termination for cause:

1. Contractor's persistent failure to perform the Work in accordance with the Contract Documents (including, but not limited to, failure to supply sufficient skilled workers or suitable materials or equipment or failure to adhere to the Progress Schedule established under Paragraph 2.07 as adjusted from time to time pursuant to Paragraph 6.04);

2. Contractor's disregard of Laws or Regulations of any public body having jurisdiction;

3. Contractor's repeated disregard of the authority of Engineer; or

4. Contractor's violation in any substantial way of any provisions of the Contract Documents.

B. If one or more of the events identified in Paragraph 15.02.A occur, Owner may, after giving Contractor (and surety) seven days written notice of its intent to terminate the services of Contractor:

1. exclude Contractor from the Site, and take possession of the Work and of all Contractor's tools, appliances, construction equipment, and machinery at the Site, and use the same to the full extent they could be used by Contractor (without liability to Contractor for trespass or conversion);

2. incorporate in the Work all materials and equipment stored at the Site or for which Owner has paid Contractor but which are stored elsewhere; and

3. complete the Work as Owner may deem expedient.

C. If Owner proceeds as provided in Paragraph 15.02.B, Contractor shall not be entitled to receive any further payment until the Work is completed. If the unpaid balance of the Contract Price exceeds all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) sustained by Owner arising out of or relating to completing the Work, such excess will be paid to Contractor. If such claims, costs, losses, and damages exceed such unpaid balance, Contractor shall pay the difference to Owner. Such claims, costs, losses, and damages incurred by Owner will be reviewed by Engineer as to their reasonableness and, when so approved by Engineer, incorporated in a Change Order. When exercising any rights or remedies under this Paragraph, Owner shall not be required to obtain the lowest price for the Work performed.

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

E. Where Contractor's services have been so terminated by Owner, the termination will not affect any rights or remedies of Owner against Contractor then existing or which may thereafter accrue. Any retention or payment of moneys due Contractor by Owner will not release Contractor from liability.

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

15.03 *Owner May Terminate For Convenience*

A. Upon seven days written notice to Contractor and Engineer, Owner may, without cause and without prejudice to any other right or remedy of Owner, terminate the Contract. In such case, Contractor shall be paid for (without duplication of any items):

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

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

3. all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) incurred in settlement of terminated contracts with Subcontractors, Suppliers, and others; and

4. reasonable expenses directly attributable to termination.

B. Contractor shall not be paid on account of loss of anticipated profits or revenue or other economic loss arising out of or resulting from such termination.

15.04 *Contractor May Stop Work or Terminate*

A. If, through no act or fault of Contractor, (i) the Work is suspended for more than 90 consecutive days by Owner or under an order of court or other public authority, or (ii) Engineer fails to act on any Application for Payment within 30 days after it is submitted, or (iii) Owner fails for 30 days to pay Contractor any sum finally determined to be due, then Contractor may, upon seven days written notice to Owner and Engineer, and provided Owner or Engineer do not remedy such suspension or failure within that time, terminate the Contract and recover from Owner payment on the same terms as provided in Paragraph 15.03.

B. In lieu of terminating the Contract and without prejudice to any other right or remedy, if Engineer has failed to act on an Application for Payment within 30 days after it is submitted, or Owner has failed for 30 days to pay Contractor any sum finally determined to be due, Contractor may, seven days after written notice to Owner and Engineer, stop the Work until payment is made of all such amounts due Contractor, including interest thereon. The provisions of this Paragraph 15.04 are not intended to preclude Contractor from making a Claim under Paragraph 10.05 for an adjustment in Contract Price or Contract Times or otherwise for expenses or damage directly attributable to Contractor's stopping the Work as permitted by this Paragraph.

ARTICLE 16 – DISPUTE RESOLUTION

16.01 *Methods and Procedures*

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

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

C. If the Claim is not resolved by mediation, Engineer's action under Paragraph 10.05.C or a denial pursuant to Paragraphs 10.05.C.3 or 10.05.D shall become

final and binding 30 days after termination of the mediation unless, within that time period, Owner or Contractor:

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

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

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

ARTICLE 17 – MISCELLANEOUS

17.01 *Giving Notice*

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

1. delivered in person to the individual or to a member of the firm or to an officer of the corporation for whom it is intended; or

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

17.02 *Computation of Times*

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

17.03 *Cumulative Remedies*

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

17.04 *Survival of Obligations*

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

17.05 *Controlling Law*

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

17.06 *Headings*

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

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.42 to 1.01.A.42.a, and add the following new paragraph:

> 1.01.A.42.b. *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.44:

> 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-1.01. Add the following new paragraph immediately after Paragraph 1.01.A.51:

> 1.01.A.52. *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.

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

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

SC-2.02. Amend first sentence in Paragraph 2.02.A to read as follows:

2.02.A. Owner will furnish Contractor two hard copies of the Drawings and Project Manual and one set in electronic format.

SC-2.03. Delete the third sentence of Paragraph 2.03.A in its entirety.

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

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

SC-4.02. Add the following new paragraph(s) immediately after Paragraph 4.02.B:

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

4.02.C.1. Report dated December 21, 1990 prepared for Crosstown WTP by ATEC Associates and supplemental design memo by CH2M HILL dated March 2014.

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

4.02.D.1. Crosstown WTP Drawings: Revised Jan. 24, 1985 Contract 1 4.0 MGD Water Treatment Plant by Mallet V. Associates; and 1991 Water Treatment Plant Expansion by Mallet V. Associates.

4.02.E. Copies of reports and Drawings itemized in SC-4.02.C and SC-4.02.D that are not included with Bidding Documents may be examined at Fayette County Water System Office, 245 McDonough Road, Fayetteville, Georgia 30124 during regular business hours. These reports and Drawings are not part of the Contract Documents.

SC-4.06. Delete Paragraphs 4.06.A and 4.06.B in their entirety and insert the following in their place:

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

SC-5.01. Delete the second sentence in Paragraph 5.01.C and insert the following in its place:

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 5.01.B and 5.02.

SC-5.01. Add the following new paragraph(s) immediately following Paragraph 5.01.C:

5.01.D. Letters of Credit:

5.01.D.1. Pursuant to Federal Procurement Regulations, letters of credit may be substituted for Performance and Payment Bonds. A separate letter of credit will be required for the Performance Bond and the Payment Bond, each in the full amount of the Contract Price. Provide Owner with irrevocable letters of credit from an acceptable federally insured financial institution that has an investment grade or higher rating from a recognized commercial rating service.

5.01.D.2. Letters of credit in excess of $5 million must be confirmed by a second bank, with an acceptable rating, that has had a letter of credit business in the past year of at least $25 million. Letter of credit coverage shall extend through the correction period for performance guarantees and through the state specific period for bringing law suits for payment guarantees.

5.01.D.3. If sequential letters of credit are provided, it is Contractor's responsibility to replace the expiring letter of credit at least 30 days prior to the expiration date. Failure by Contractor to replace the expiring letter of credit may result in Owner drawing on the letter of credit.

SC-5.02. Add the following new paragraph immediately after Paragraph 5.02.A:

SC-5.02.B. 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 VII in addition to other requirements specified herein.

SC-5.03. Delete Paragraph 5.03.B in its entirety.

SC-5.04. Add the following language after Paragraph 5.04.B.1:

Include the following parties or entities as additional insured:

5.04.B.1.a. Fayette County, Georgia, 140 Stonewall Avenue West, Suite 204, Fayetteville, Georgia 301214

5.04.B.1.b**.** CH2M HILL, 6600 Peachtree Dunwoody Road, Embassy Row 400 Suite 600, Atlanta GA 30328.

SC-5.04. Add the following new paragraph immediately following Paragraph 5.04.B:

5.04.C. The limits of liability for the insurance required by Paragraph 5.04 of the General Conditions shall provide coverage for not less than the following amounts or greater where required by Laws and Regulations:

5.04.C.1. Workers' Compensation and related coverages under Paragraphs 5.04.A.1 and 5.04.A.2 of the General Conditions:

5.04.C.1.a. State: Statutory.

5.04.C.1.b. Applicable Federal (e.g., Longshoreman's): Statutory.

5.04.C.1.c. Employer's Liability: $1,000,000

5.04.C.2. Contractor's General Liability under Paragraphs 5.04.A.3 through 5.04.A.6 of the General Conditions which shall include completed operations and product liability coverages and eliminate the exclusion with respect to property under the care, custody and control of Contractor:

5.04.C.2.a. General Aggregate $1,000,000

5.04.C.2.b. Products - Completed Operations Aggregate $1,000,000

5.04.C.2.c. Personal and Advertising Injury (per person/Organization) $1,000,000

5.04.C.2.d. Each Occurrence (Bodily Injury and Property Damage) $1,000,000

5.04.C.2.e. Property Damage liability insurance will provide Explosion, Collapse, and Underground coverages where applicable.

5.04.C.2.f. Excess or Umbrella Liability:

1) General Aggregate $5,000,000

2) Each Occurrence $5,000,000

5.04.C.3. Automobile Liability under Paragraph 5.04.A.6 of the General Conditions:

5.04.C.3.a. Bodily Injury:

Each Person $1,000,000

Each Accident $ 1,000,000

5.04.C.3.b. Property Damage:

Each Accident	$1,000,000

5.04.C.3.c. Combined Single Limit of $1,000,000

5.04.C.4. Contractual Liability coverage required by Paragraph 5.04.B.3 of the General Conditions shall provide coverage for not less than the following amounts:

5.04.C.4.a. Bodily Injury:

Each Accident	$1,000,000
Annual Aggregate	$5,000,000

5.04.C.4.b. Property Damage:

Each Accident	$1,000,000
Annual Aggregate	$5,000,000

5.04.C.5. Provide the following additional types of insurance:

5.04.C.5.a. Pollution Liability: $2,000,000

5.04.C.5.b. Builder's Risk

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

5.06.A. Contractor shall purchase and maintain property insurance upon the Work at the Site in the amount of the full replacement cost thereof. Contractor shall be responsible for any deductible or self-insured retention. This insurance shall:

5.06.A.1. include the interests of Owner, Contractor, Subcontractors, Engineer and any other individuals or entities identified herein, and the officers, directors, members, partners, employees, agents, and other consultants and subcontractors of any of them, each of whom is deemed to have an insurable interest and shall be listed as an insured or loss payee;

5.06.A.3. be written on a Builder's Risk "all-risk" policy form that shall at least include insurance for physical loss and damage to the Work, temporary buildings, false work, and materials and equipment in transit and shall insure against at least the following perils or causes of loss: fire, lightning, extended coverage, theft, vandalism and malicious mischief, earthquake, collapse, debris removal, demolition occasioned by enforcement of Laws and Regulations, water damage (other than that caused by flood), and such other perils or causes of loss as may be specifically required by these Supplementary Conditions;

5.06.A.4. include expenses incurred in the repair or replacement of any insured property (including but not limited to fees and charges of engineers and architects);

5.06.A.5. cover materials and equipment stored at the Site or at another location that was agreed to in writing by Owner prior to being incorporated in the Work, provided that such materials and equipment have been included in an Application for Payment recommended by Engineer;

5.06.A.6. allow for partial utilization of the Work by Owner;

5.06.A.7. include testing and startup;

5.06.A.8. 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

5.06.A.9. Comply with the requirements of Paragraph 5.06.C of the General Conditions.

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

5.06.B. Equipment breakdown insurance is not required for this Project.

SC-5.06. Delete Paragraph 5.06.E in its entirety and insert the following in its place:

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

SC-5.07. Delete the last sentence of Paragraph 5.07.A in its entirety and insert the following in its place:

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 Contractor as trustee or otherwise payable under any policy so issued.

SC-5.08. Delete Paragraph 5.08.A in its entirety and insert the following in its place:

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

SC-5.08. Delete Paragraph 5.08.B in its entirety and insert the following in its place:

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

SC-5.10. Add the following language to the end of Paragraph 5.10.A:

The property insurance shall contain no partial occupancy restriction for utilization of the Project by Owner for the purpose intended.

SC-6.02. Add the following language to the end of Paragraph 6.02.B:

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

6.02.C. Contractor shall reimburse Owner for Engineer's additional extraordinary costs for onsite personnel overtime work resulting from Contractor's overtime operations. Reimbursement shall be on the cost basis defined in Paragraph 14.02.D.4 of these Supplementary Conditions.

SC-6.05. Add the following language at the end of Paragraph 6.05.E:

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 14.02.D.4 of these Supplementary Conditions.

SC-6.06. Add the following language at the end of Paragraph 6.06.A:

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

SC-6.06. Add the following new paragraph immediately after Paragraph 6.06.G:

6.06.H. 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 a particular Subcontractor or Supplier.

SC-6.08. Add the following new paragraphs immediately after Paragraph 6.08.A:

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

6.08.B.1. GA EPD.

6.08.B.2. Appropriate Fayette County Departments

SC-6.09. Add the following new paragraph(s) immediately after Paragraph 6.09.C:

6.09.D. While not intended to be inclusive of all Laws or Regulations for which Contractor may be responsible under Paragraph 6.09, the following Laws or Regulations are included as mandated by statute or for the convenience of Contractor:

6.09.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-6.11. Add the following language to the end of Paragraph 6.11.A.1:

Contractor shall not enter upon nor use property not under Owner control until appropriate easements have been executed and a copy is on file at the Site**.**

SC-6.17. Add the following new paragraphs immediately after Paragraph 6.17.E.1:

6.17.E.2. Contractor shall furnish required submittals with sufficient information and accuracy in order to obtain required approval of an item with no more than the number of submittals specified in Paragraph 14.02.D.4 of these Supplementary Conditions. Engineer will record time for reviewing subsequent submittals of Shop Drawings, Samples, or other items requiring approval and Contractor shall reimburse Owner for Engineer's charges for such time in accordance with Paragraph 14.02.D.4 of these Supplementary Conditions.

6.17.E.3. In the event Contractor requests a substitution for a previously approved item, Contractor shall reimburse Owner for Engineer's charges for such time, unless the need for such substitution is beyond the control of Contractor.

SC-7.04. Add the following new paragraph immediately after Paragraph 7.03:

SC-7.04. *Claims Between Contractors*

7.04.A. Should Contractor cause damage to the work or property of any other contractor at the Site, or should any claim arising out of Contractor's performance of the Work at the Site be made by any other contractor against Contractor, Owner, Engineer, or the Construction Coordinator, if applicable, Contractor shall (without involving Owner, Engineer, or Construction Coordinator) either i) remedy the damage; ii) agree to compensate the other contractor for remedy of the damages; or iii) remedy the damages and attempt to settle with such other contractor by agreement, or to otherwise resolve the dispute by arbitration or at law.

7.04.B. Contractor shall, to the fullest extent permitted by Laws and Regulations, indemnify and hold harmless Owner, Engineer, the Construction Coordinator (if applicable) and the officers, directors, members, partners, employees, agents, and other consultants and subcontractors of each and any of them from and against all Claims, costs, losses and damages (including, but not limited to, fees and charges of engineers, architects, attorneys, and other professionals and court and arbitration costs) arising directly, indirectly or consequentially out of any action, legal or equitable, brought by any other contractor against Owner, Engineer, their officers, directors, members, partners, employees, agents, and other consultants and subcontractors, or the Construction Coordinator (if applicable) to the extent said Claim is based on or arises out of Contractor's performance of the Work. Should another contractor cause damage to the Work or property of Contractor or should the performance of Work by any other contractor at the Site give rise to any other Claim, Contractor shall not institute any action, legal or equitable, against Owner, Engineer, or the Construction Coordinator (if applicable) or permit any action against any of them to be maintained and continued in its name or for its benefit in any court or before any arbiter which seeks to impose liability on or to recover damages from Owner, Engineer, or the Construction Coordinator (if applicable) on account of any such damage or Claim.

7.04.C. If Contractor is delayed at any time in performing or furnishing the Work by any act or neglect of another contractor, and Owner and Contractor are unable to agree as to the extent of any adjustment in Contract Times attributable thereto, Contractor may make a Claim for an extension of times in accordance with Article 12. An extension of the Contract Times shall be Contractor's exclusive remedy with respect to Owner, Engineer, and Construction Coordinator (if applicable) for any delay, disruption, interference, or hindrance caused by any other contractor. This paragraph does not prevent recovery from Owner, Engineer, or Construction Coordinator (if applicable) for activities that are their respective responsibilities.

SC-8.11. Add the following new paragraph immediately after Paragraph 8.11.A:

8.11.B. On request of Contractor, prior to the execution of any Change Order involving a significant increase in the Contract Price, Owner will furnish to Contractor reasonable evidence that adequate financial arrangements have been made by Owner to enable Owner to fulfill the increased financial obligations to be undertaken by Owner as a result of such Change Order.

SC-9.03. Add the following new paragraphs immediately after Paragraph 9.03.A:

9.03.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 9.09 and as set forth elsewhere in the Contract Documents and are further limited and described below.

9.03.C. Responsibilities and Authority:

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

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

9.03.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.

9.03.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.

9.03.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.

9.03.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.

9.03.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.

9.03.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.

9.03.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, website locations, and telephone numbers of Contractors, Subcontractors, and major Suppliers of materials and equipment.

9.03.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.

9.03.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.

9.03.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.

9.03.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.

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

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

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

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

9.03.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

9.03.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

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

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

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

SC-9.09. Add the following new paragraph immediately after Paragraph 9.09.E:

9.09.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-10.05. Delete Paragraphs 10.05.C through 10.05.E in their entirety and insert the following in their place and renumber Paragraph 10.05.F to read 10.05.D:

10.05.C. Engineer's Action and Executive Negotiation:

10.05.C.1. Engineer's Action:

10.05.C.1.a. Engineer will render a formal decision in writing within 30 days after receipt of the last submittal of the claimant or the last submittal of the opposing party, if any. Engineer's written decision on such Claim, dispute or other matter will be final and binding upon Owner and Contractor, unless within 10 days after issuance of Engineer's written decision, either party appeals the decision by giving the other party and Engineer written notice of request for executive negotiation.

10.05.C.1.b. In the event Engineer does not take action on a Claim within said 30 days, the Claim shall be deemed denied.

10.05.C.2. Executive Negotiation:

10.05.C.2.a. Within 10 days of the delivery of notice of appeal to Engineer's written decision regarding Claim, dispute or other matter, senior representatives of at least Owner and Contractor, having authority to settle the dispute, and Engineer shall meet at a mutually acceptable time and place, and thereafter as often as they reasonably deem necessary, to exchange relevant information and to attempt to resolve the dispute.

10.05.C.2.b. In the event a mutually acceptable decision cannot be reached through executive negotiation within 20 days of the appealing party's notice, or mutually agreeable longer period, or if the party receiving such notice will not meet within 10 days, Owner or Contractor may make a written declaration, delivered to the other party and Engineer, that the executive negotiation is deemed unsuccessful and may initiate further dispute resolution measures in accordance with Article 16.

10.05.C.2.c. If no such dispute resolution procedures have been set forth in Article 16, a written notice of intention to further appeal Engineer's written decision shall be delivered by Owner or Contractor to the other and to Engineer within 30 days after the date upon which the executive negotiation has been declared unsuccessful, or within 60 days after Substantial Completion, whichever is later (unless otherwise agreed in writing by Owner and Contractor), to exercise such rights or remedies as the appealing party may have with respect to such Claim, dispute, or other matter in accordance with applicable Laws and Regulations.

SC-11.01. Delete Paragraph 11.01.A.5.c in its entirety and insert the following in its place:

11.01.A.5.c. Construction Equipment and Machinery:

11.01.A.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.

11.01.A.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-11.01. Add the following language to the end of Paragraph 11.01.A.5.h:

Express and courier services must be approved prior to use.

SC-11.03. Delete Paragraph 11.03.D in its entirety and insert the following in its place:

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

11.03.D.1. if the Bid price of a particular item of Unit Price Work amounts to 5 percent or more of the Contract Price and the variation in the quantity of that particular item of Unit Price Work performed by Contractor differs by more than 15 percent from the estimated quantity of such item indicated in the Agreement; and

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

11.03.D.3. if Contractor believes that Contractor has incurred additional expense as a result thereof or if Owner believes the quantity variation entitles Owner to an adjustment in the unit price, either Owner or Contractor may make a Claim for an adjustment in the Contract Price in accordance with Article 10 if the parties are unable to agree as to the effect of any such variation in the quantity of Unit Price Work performed.

SC-12.01. Add the following language to the end of Paragraph 12.01.C.2.c:

except, the maximum total allowable cost to Owner shall be the Cost of the Work plus a maximum collective aggregate fee for Contractor and tiered Subcontractors of 26.8 percent;

SC-12.01. Add the following new paragraph immediately after Paragraph 12.01.C:

12.01.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-13.03. Delete Paragraph 13.03.B in its entirety and insert the following in its place:

13.03.B. Contractor shall employ an independent testing laboratory or testing agency and shall be responsible for arranging and shall pay for specified tests, inspections, and approvals required for Owner's and Engineer's acceptance of the Work at the Site except:

13.03.B.1. costs incurred in connection with tests or inspections pursuant to Paragraph 13.04 shall be paid for as provided in said paragraph; and

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

SC-13.03. Add the following language at the end of Paragraph 13.03.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:

13.03.D.1. Basic requirements of ASTM E329, "Standard Specification for Agencies Engaged in Construction Inspection, Special Inspection, or Testing Materials used in Construction" as applicable.

13.03.D.2. 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-14.02. Delete Paragraph 14.02.C.1 in its entirety and insert the following in its place:

14.02.C.1. Thirty days after presentation of the Application for Payment to Owner with Engineer's recommendation, the amount recommended will (subject to the provisions of Paragraph 14.02.D) become due and when due will be paid by Owner to Contractor.

SC-14.02. Add the following new paragraph(s) immediately after Paragraph 14.02.D.3:

14.02.D.4. Items entitling Owner to retain set-offs from the amount recommended, including but not limited to:

14.02.D.4.a. Owner compensation to Engineer at an estimated average rate of $130 per each extra personnel hour for labor plus expenses, if applicable, because of the following Contractor-caused events:

14.02.D.4.a.(2). return visits to manufacturing facilities to witness factory testing or retesting;

14.02.D.4.a.(3). Submittal review in excess of two reviews by Engineer for substantially the same submittal, in accordance with Paragraphs 6.17.E.2 and 6.17.E.3 of these Supplementary Conditions;

14.02.D.4.a.(4). evaluation of proposed substitutes and making changes to Contract Documents occasioned thereby, in accordance with Paragraph 6.05.E of these Supplementary Conditions;

14.02.D.4.a.(5). Overtime worked by Contractor necessitating Engineer, and their officers, directors, members, partners, employees, agents, and other consultants and subcontractors of each, Resident Project Representative or Resident Project Representative's Site staff, if any, to work extraordinary overtime in accordance with Paragraph 6.02.C. of these Supplementary Conditions.

14.02.D.4.b. Liability for liquidated damages incurred by Contractor as set forth in the Agreement.

SC-15.03.A. Delete the first sentence of Paragraph 15.03.A in its entirety and insert the following in its place:

Upon 7 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 or any portion of the Contract.

SC-16.01. Delete Paragraph 16.01 in its entirety and insert the following in its place:

SC-16.01 *Meet to Confer and Negotiate*

16.01.A. Engineer's action under Paragraph 10.05.C shall become final and binding 30 days after receipt of written notice of Engineer's action or decision unless, within that time period, Owner or Contractor gives to the other party written notice of intent to submit the Claim to a process of bilateral negotiations as set forth below.

16.01.B. Within 30 days of the delivery of such notice, Owner and Contractor shall meet and confer regarding the Claim. A good-faith effort to negotiate resolution shall be made by both parties.

16.01.C. If the negotiations contemplated by Paragraph SC-16.01.B are unsuccessful, management representatives of Owner and Contractor at least one tier above the individuals who met under SC-16.01.B shall meet, confer, and negotiate within 30 days of the closure of the unsuccessful negotiations.

16.01.D. If the Claim is not resolved by negotiation, Engineer's action under Paragraph 10.05.C shall become final and binding 30 days after termination of the negotiations unless, within that time period, Owner or Contractor:

16.01.D.1. gives to the other party written notice of intent to submit the Claim to a court of competent jurisdiction; or

16.01.D.2. agrees with the other party to submit the Claim to another dispute resolution process.

16.01.E. Notwithstanding any applicable statute of limitations, a party giving notice under Paragraph SC-16.01.D.1 shall commence an action on the Claim within 1 year of giving such notice. Failure to do so shall result in the Claim being time-barred and Engineer's action or denial shall become final and binding.

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 new powdered activated carbon storage and feed system; a new chlorine dioxide storage and feed system; rehabilitation of the existing eight filters; selective demolition; yard piping for new and existing facilities; electrical system improvements to support new loads; computer-based controls associated with improvements; site development and storm water management.

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 11.01.A.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. Consult with Engineer in selection of products or services. Obtain proposals from Suppliers and installers, and offer recommendations.

B. Cash allowances will be administered in accordance with Paragraph 11.02 of General Conditions.

C. 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. Unit Price Work: Reflect unit price quantity and price breakdown from conformed Bid Form.

C. Lump Sum Work:

1. Reflect specified allowances and alternates, 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 with appropriate subdivision of each Specification and for each Project facility.

D. An unbalanced or front-end loaded schedule will not be acceptable.

E. 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 and detailed Application for Payment Form(s), 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.

1.08 PARTIAL PAYMENT FOR UNDELIVERED, PROJECT-SPECIFIC MANUFACTURED OR FABRICATED EQUIPMENT

A. Notwithstanding above provisions, partial payments for undelivered (not yet delivered to Site or not stored in the vicinity of Site) products specifically manufactured for this Project, excluding off the shelf or catalog items, will be made for products listed below when all following conditions exist:

1. Partial payment request is supported by written acknowledgment from Suppliers that invoice requirements have been met.
2. Equipment is adequately insured, maintained, stored, and protected by appropriate security measures.
3. Each equipment item is clearly marked and segregated from other items to permit inventory and accountability.
4. Authorization has been provided for access to storage Site for Engineer and Owner.
5. Equipment meets applicable Specifications of these Contract Documents.

B. Applicable Items:

Specification Section	Specific Product
40 99 91	Filter Package Control System
44 43 30	Filter Media
44 43 34	Filter Underdrain System

C. Payment of 15 percent of manufacturer's quoted price for undelivered, Project-specific manufactured equipment will be made following Shop Drawing approval. Thereafter, monthly payments will be made based on progress of fabrication as determined by Engineer, but in no case will total of payments prior to delivery exceed 75 percent of manufacturer's quoted price.

D. Failure of Contractor to continue compliance with above requirements shall give cause for Owner to withhold payments made for such equipment from future partial payments.

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 RELATED WORK AT SITE

A. General:

1. Other Work that is either directly or indirectly related to scheduled performance of the Work under these Contract Documents, listed henceforth, is anticipated to be performed at Site by others.
   a. Chemical Systems and Actuator Improvements Bid #913, February 2015.
2. Coordinate the Work of these Contract Documents with work of others as specified in General Conditions.
3. Include sequencing constraints specified herein as a part of Progress Schedule.

1.03 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. Electricity Company: Georgia Power.
   a. Contact Person: Seth Collins.
   b. Telephone: 770.254.7129 (o) / 404.213.1711 (m).
2. Water Department: Owner.
3. Phone (fax): AT&T.
4. Phone (voice)/Internet: Comcast.

1.04 CONSTRUCTION SEQUENCE AND CONSTRAINTS

A. General:

1. The Contractor shall be solely responsible for all construction sequencing.
2. The completion of specific preliminary sequencing tasks indicated will be required prior to any significant Site demolition.

B. The Contractor is required to notify the Owner and the Engineer at least 14 days prior to starting to relocate piping or removing existing plant components out of service. The Contractor shall allow mandatory coordination meetings to review and discuss plant shutdowns, tie-ins, and electrical service coordination issues. Contractor shall prepare written, detailed plans on sequencing activities and have standby equipment available in the event some of the existing equipment is damaged and must be repaired.

C. The information provided herein should not be relied upon by Contractor as fully complete, comprehensive, or fully detailed. Contractor shall make his own assessment and determination of requirements that affect or may affect the progress, sequence, or cost of the Work.

D. Sequence and constraints other than those described will be considered upon written request to Owner and Engineer, provided they afford equivalent continuity of facility operations.

E. Modifications at the Crosstown Water Treatment Plant:

1. Filter Building:
    a. Filter Nos. 1-8: Maximum of two filters can be shutdown between June 1 to August 31. During no time will more than four filters be shutdown. Plant partial or complete shutdown is dependent on distribution system demands and system operational requirements with the South Fayette Water Treatment Plant. The Owner reserves the right to reject request for partial or complete shutdown. Work shall first begin with Filter Nos. 5-8 and include No. 7 which is not operational. Completed Filters shall have been tested without interruption for 15-days prior to shutting down additional Filters.
    b. Pipe Gallery Combined Filter Turbidimeter: Unit shall be temporarily relocated during the Work before final installation. Shutdown shall be limited to 1 day each occurrence.
    c. Pipe Gallery Filter Influent Main Header Isolation Valves – Shutdown for replacement of the three valves shall be limited to an 8 hour period. Work shall occur before commencing work on Filter Nos. 5-8.
    d. Pipe Gallery Washwater Drain Main Header Isolation Valve – Shutdown for replacement of valve shall be limited to an 8 hour period. Work shall occur before commencing work on Filter Nos. 5-8.
    e. Pipe Gallery Filter Effluent Main Header Isolation Valves - Shutdown for replacement of the two valves shall be limited to an 8 hour period. Work shall occur before commencing work on Filter Nos. 5-8.

f. Pipe Gallery Backwash Supply Main Header Isolation Valve - Shutdown for replacement of valve shall be limited to an 8 hour period. Work shall occur before commencing work on Filter Nos. 5-8.

g. Pipe Gallery Filter Nos. 1-4 Washwater Drain Valves – Isolation of main header to replace all valves will require temporary bypass piping. Shutdown for connection of temporary bypass piping shall be limited to an 8 hour period.

h. Pipe Gallery Filter Nos. 1-4 Backwash Supply Valves – Isolation of main header to replace all valves will require shutdown of Filter Nos. 5-8. Shutdown for replacement of valves shall be limited to an 8 hour period. The work could be coordinated with shutdown for main header isolation valve replacement listed above.

2. Backwash ROF Controller: Backwash shutdown from the Finished Water Pump Station No. 1 of Filter Nos. 1-8 for the installation and operation of the new ROF Controller shall be limited to a total of 4 days. Shutdown between June 1st and August 31st is not allowed.
3. Surface Backwash Piping: Once all Filter work is complete, Contractor shall coordinate with Owner to isolate the existing surface backwash line from the Finished Water Pump Station No. 1 to Filter Nos. 1-8 prior to demolition. The pipe will need to remain in operation for any Filters that have not been rehabilitated.
4. Chemical Building: Potassium Permanganate system shall be demolished only after new Sodium Permanganate system under separate contract has been in operation for 15-days.
5. Chemical Building: Chlorine Dioxide system shall be demolished only after new system has been in operation for 30-days.
6. Any shutdown of the plant required to construct the Work must be less than 8 hours in duration, unless otherwise specified or approved.

1.05 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. No materials or equipment are to be stored on the clearwells.

E. 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.

F. Process or Facility Shutdown:

1. The following may require shutdown at some time during the Work:
   a. Crosstown WTP:
      1) Lake McIntosh Meter Vault.
      2) Raw Water Meter Vault.
      3) Chemical Feed Vault.
      4) Filter Building Filter Nos. 1-8.
      5) Backwash piping.
      6) Filter Influent piping.
      7) Filter Effluent piping.
      8) Washwater Drain piping.
      9) Surface wash piping.
2. Provide 14 days advance written request for approval of need to shut down a process or facility to Owner and Engineer.
3. Power outages will be considered upon 72 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.

G. 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.

H. 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.

1.06 ADJACENT FACILITIES AND PROPERTIES

A. Examination:

1. After Effective Date of the Agreement and before Work at Site is started, Contractor, Engineer, and affected property owners and utility owners 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: Record and submit documentation of observations made on examination inspections in accordance with Article Construction Photographs.

1.07 CONSTRUCTION PHOTOGRAPHS

A. General:

1. Photographically document all phases of the Project including preconstruction, construction progress, and post-construction.
2. 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 48 photographs of Site and property adjacent to perimeter of Site.
2. Particular emphasis shall be directed to structures both inside and outside the Site.
3. Format: Digital, minimum resolution of 1,680 by 2,240 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 1,680 by 2,240 pixels and 24-bit, millions of color. Submit with Payment Application.

1.08 REFERENCE POINTS AND SURVEYS

A. Contractor's Responsibilities:

1. Provide additional survey and layout required to layout the Work.
2. Notify Engineer at least 3 working days in advance of time when grade and line to be provided by Owner will be needed.
3. Check and establish exact location of existing facilities prior to construction of new facilities and any connections thereto.
4. In event of discrepancy in data or staking provided by Owner, request clarification before proceeding with Work.
5. Maintain complete accurate log of survey work as it progresses as a Record Document.
6. On request of Engineer, submit documentation.
7. Provide competent employee(s), tools, stakes, and other equipment and materials as Engineer may require to:
   a. Establish control points, lines, and easement boundaries.
   b. Check layout, survey, and measurement work performed by others.
   c. Measure quantities for payment purposes.

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 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.
5. Scheduled by Engineer on regular basis and as necessary to review.

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 2.05 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 utilized for execution of the Work.
   b. Progress Schedule: One legible copies.
   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 30 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. Contractor may use Schedule of Submittals specified in Section 01 33 00, Submittal Procedures.
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 Milestone and Completion Dates.
9. Owner-furnished products delivery dates or ranges of dates.
10. Major structural, mechanical, equipment, electrical, architectural, and instrumentation and control Work.

11. System startup summary.
12. Project close-out summary.
13. 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 monthly 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, constraints, and Milestones, including Substantial Completion date(s).
5. Subcontract Work.
6. Major equipment design, fabrication, factory testing, and delivery dates.
7. Delivery dates for Owner-furnished products, as specified in Section 01 11 00, Summary of Work.
8. Sitework.
9. Concrete Work.
10. Structural steel Work.
11. Architectural features Work.
12. Conveying systems Work.
13. Equipment Work.
14. Mechanical Work.
15. Electrical Work.
16. Instrumentation and control Work.
17. Interfaces with Owner-furnished equipment.
18. Other important Work for each major facility.
19. Equipment and system startup and test activities.
20. Project closeout and cleanup.
21. 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 Contractor fails to complete activity by its latest scheduled completion date and this Failure is anticipated to extend Contract Times (or Milestones), Contractor shall, within 7 days of such failure, submit a written statement as to how Contractor intends to correct nonperformance and return to acceptable current Progress Schedule. Actions by Contractor to complete the Work within Contract Times (or Milestones) 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:

1. Complete a Milestone activity by its completion date.
2. 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 (e.g., lay down and staging areas, construction traffic), utilization 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 and all intermediate Milestones are within the specified times.
   b. Specified Work sequences and constraints are shown as specified.
   c. Specified Owner-furnished Equipment or Material arrival dates, or range of dates, are included.
   d. Access restrictions are accurately reflected**.**
   e. Startup and testing times are as specified.
   f. Submittal review times are as specified.
   g. 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, during which time Contractor shall update 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, Contractor shall 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. Contractor shall 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. 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. 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. Provide Engineer with authorization to reproduce and distribute each file as many times as necessary for Project documentation.
9. 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) Submittal number shall be the Specification number followed by .XX.YY, where XX begins at 00 and refers to multiple submittals associated with a single Specification and YY begins at 00 and refers to the original (00) or resubmittal (01 for first resubmittal, 02 for second resubmittal, etc.).
   b. If a submittal covers only a portion of a Specification section, indicate the paragraph(s) in the Specification 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. 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 30 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.

F. Resubmittals: Clearly identify each correction or change made.

G. 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.
   c. Insufficient number of copies.

H. 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. Copies: If electronic submittals are not provided, submit six hard copies.
2. 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.

3. 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.
4. Product Data: Provide as specified in individual Specifications.
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:
      1) One copy furnished Owner.
      2) One copy furnished Resident Project Representative.
      3) One copy retained in Engineer's file.
      4) Remaining copies returned to Contractor appropriately annotated.
2. Approved as Noted:
   a. Contractor may incorporate product(s) or implement Work covered by submittal, in accordance with Engineer's notations.
   b. Distribution:
      1) One copy furnished Owner.
      2) One copy furnished Resident Project Representative.
      3) One copy retained in Engineer's file.
      4) Remaining copies returned to Contractor appropriately annotated.
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:
      1) One copy furnished Owner.
      2) One copy furnished Resident Project Representative.

3) One copy retained in Engineer's file.
4) Remaining copies returned to Contractor appropriately annotated.

4. Revise and Resubmit:
   a. Contractor may not incorporate product(s) or implement Work covered by submittal.
   b. Distribution:
      1) One copy furnished Resident Project Representative.
      2) One copy retained in Engineer's file.
      3) Remaining copies returned to Contractor appropriately annotated.

1.04 INFORMATIONAL SUBMITTALS

A. General:

1. Copies: If electronic submittals are not provided, submit three copies, unless otherwise indicated in individual Specification section.
2. Refer to individual Specification sections for specific submittal requirements.
3. 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. Manufacturer's Instructions: Written or published information that documents manufacturer's recommendations, guidelines, and procedures in accordance with individual Specification section.

G. Operation and Maintenance Data: As required in Section 01 78 23, Operation and Maintenance Data.

H. 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.

I. Schedules:

1. Progress Schedules: In accordance with Section 01 32 00, Construction Progress Documentation.

J. Special Guarantee: Supplier's written guarantee as required in individual Specification sections.

K. 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.52 of Supplementary Conditions for definition of Specialist.

L. 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.

M. 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.

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

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

1.05 SUPPLEMENTS

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

1. Form: 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**: _____ Contractor _____ _____ _____	Submittal No.: _____ ☐ New Submittal ☐ Resubmittal Project: _____ Project No.: _____ Specification Section No.: _____ **(Cover only one section with each transmittal)** Schedule Date of Submittal: _____

SUBMITTAL TYPE:	☐ Shop Drawing	☐ Sample	☐ Informational
	☐ 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 No.	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 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, 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 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' 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. 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 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.

3.04 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.

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, demonstration, hands-on).
5. Instruction materials and equipment requirements.
6. Resumes of instructors providing training.

D. Training: 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.

E. Recording of Training Sessions:

1. Furnish audio and color recording of 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.
4. Include one training session on each DVD.

3.05 SUPPLEMENTS

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

1. Form: Manufacturer's Certificate of Proper Installation.
2. Form: Manufacturer's Certificate of Compliance.

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)

MANUFACTURER'S CERTIFICATE OF COMPLIANCE

OWNER: _____

PROJECT NAME: _____

PROJECT NO: _____

PRODUCT, MATERIAL, OR SERVICE SUBMITTED: _____

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: _____

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 SUBMITTALS

A. Informational Submittals:

1. CQC Plan: Submit, not later than 30 days after receipt of Notice to Proceed.
2. CQC Report: Submit, weekly, an original and one copy in report form.

1.04 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, both onsite and offsite, 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. Notify Owner at least 48 hours in advance of beginning any of the required action of the preparatory phase.
   b. 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.
   c. Document the results of the preparatory phase meeting by separate minutes prepared by the CQC System Manager and attached to the QC report.
   d. 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.
      10) Check to verify that the plan for the Work to be performed, if so required, has been accepted by Engineer.
2. Initial Phase:
   a. Accomplish at the beginning of a definable feature of Work:
      1) Notify Owner at least 48 hours in advance of beginning the initial phase.

2) 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.
3) 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.
4) 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 a chart showing lines of authority and 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. Letters of Authority: A copy of a letter to the CQC System Manager signed by an authorized official of the firm, describing the responsibilities and delegating sufficient authorities to adequately perform the functions of the CQC System Manager, including authority to stop Work which is not in compliance with the Contract. The CQC System Manager shall issue letters of direction to all other various quality control representatives outlining duties, authorities and responsibilities. Copies of these letters will also be furnished to Owner.
    d. Submittals: Procedures for scheduling, reviewing, certifying, and managing submittals, including those of subcontractors, offsite fabricators, suppliers and purchasing agents.
    e. 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.
    f. Procedures for tracking preparatory, initial, and follow-up control phases and control, verification, and acceptance tests, including documentation.
    g. Procedures for tracking deficiencies from identification through acceptable corrective action. These procedures will establish verification that identified deficiencies have been corrected.
    h. 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 7 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. Identify submittals reviewed, with Contract reference, by whom, and action taken.
7. Offsite surveillance activities, including actions taken.
8. Job safety evaluations stating what was checked, results, and instructions or corrective actions.
9. List instructions given/received and conflicts in Drawings and/or Specifications.
10. Contractor's verification statement.

11. Indicate a description of trades working on the Project; the number of personnel working; weather conditions encountered; and any delays encountered.
12. 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. 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 or any milestone established by a completion time stated in the Contract.

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 and is in addition to and supplements requirements included in Statement of Special Inspections (Plan) shown on Drawings.

1.02 REFERENCES

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

1. International Code Council (ICC):
   a. 2012 International Building Code (IBC).
   b. Evaluation Service (ICC-ES) Reports and Legacy Reports.
   c. Fayette County, GA Code of Ordinances
2. American Society of Civil Engineers (ASCE): 7-10**,** Minimum Design Loads for Buildings and Other Structures.

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.
2. Registered Design Professional in Responsible Charge: An individual who is registered or licensed to practice their respective design profession as defined by the statutory requirements of the professional registration laws of the state or jurisdiction in which the Project is to be constructed.
3. Special Inspector: Qualified person employed by Owner who will demonstrate competence to the satisfaction of the building official for inspection of a particular type of construction or operation requiring Special Inspection.

B. 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 the area where the Work is being performed.
3. Special Inspection, Periodic: Part-time or intermittent observation of Work requiring Special Inspection by an approved Special Inspector who is present in the area where the Work has been or is being performed, and at the completion of the Work.

C. Structural Systems and Components:

1. 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.
2. Shear Wall: Component of structural lateral load resisting system consisting of a wall designed to resist lateral forces parallel to the 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.
3. 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.

D. Nonstructural Components:

1. Architectural Component Supports: Structural members or assemblies of members which transmit loads and forces from architectural systems or components to the structure, including braces, frames, struts, and attachments.
2. Electrical Component Supports: 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.
3. Mechanical Component Supports: 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.

E. 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 (Plan) provided on Drawings.
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.
5. Statement of Special Inspections (Plan): Detailed written procedure contained on Drawings 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.

1.04 SUBMITTALS

A. Informational Submittals:

1. Contractor's Statement of Responsibility: Form shall be completed by each contractor responsible for construction of a main seismic-force-resisting system, and seismic-resisting component listed in Statement of Special Inspections (Plan). Refer to Article Supplements located at end of section.
2. Component Manufacturer's Seismic Certificate of Compliance Form: Submit for mechanical and electrical components having a Component Importance Factor of 1.5 as designated hereinafter. Refer to Article Supplements located at end of section.

1.05 STATEMENT OF SPECIAL INSPECTIONS (PLAN) REQUIREMENTS

A. Designated Systems for Inspection:

1. Seismic-force-resisting systems designated under IBC Section 1705 and subject to Special Inspection under Section 1707: 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 None required.

3. Architectural, Mechanical, and Electrical Components subject to Special Inspection and testing under IBC Section 1707 for Seismic Resistance: as listed in Table below:

Architectural, Mechanical, and Electrical Components designated under IBC Section 1705 Mechanical and Electrical Components Require Certification of Compliance for Seismic Testing or Analysis under IBC Section 1708.5		
Facility	**Component**	**Component Importance Factor, IP**
Chemical Storage Tanks	Purate Tank	1.5
Chemical Storage Tanks	Sulfuric Acid Tank	1.5
Powdered Activated Carbon Storage	Powdered Activated Carbon Storage and Feed System	1.5

B. Statement of Special Inspections (Plan):

1. As included in Drawings and in support of the building permit application, the Project specific plan was prepared by the registered design professional in responsible charge. The following identifies elements of the inspection, observation and testing program to be followed in construction of the Work:
   a. Designated seismic systems and main seismic force resisting systems and components that are subject to Special Inspection Structural Observation for lateral load resistance.
   b. Special Inspection and testing required by IBC Section 1704 and Section 1708, 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. Owner will secure and pay for the services of the agency to perform Special Inspection and associated testing.

D. Owner's plan for code required Special Inspection with associated testing Professional Observation, as provided in Statement of Special Inspections (Plan) on Drawings and further provided in this section, is for the sole 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 on Site 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 due to rejection of materials of in place Work that cannot be made compliant to Contract Document without additional Site visits or testing.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 GENERAL

A. Provide access to shop or Site for Special Inspection and Testing and Professional Observation.

B. 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.

C. When required by Registered Design Professional, provide access for mechanical and electrical component inspections for those items requiring certification.

D. Materials and systems, inclusive, shall be inspected during placement where Continuous Special Inspection is required.

E. Materials and systems shall be inspected during or at completion of their placement where Periodic Special Inspection is allowed.

1. Periodic Special Inspection shall be performed so that Work inspected after, but not during, its placement can be corrected prior to other related Work proceeding and covering inspected Work.
2. Periodic Special Inspection does not allow sampling of a portion of the Work. All Work shall be inspected.

3.02 MECHANICAL AND ELECTRICAL COMPONENTS CERTIFICATION

A. Provide certificate of compliance for mechanical and electrical component testing and certification on form located at end of section.

3.03 TESTING

A. Component and attachment testing shall be required of component manufacturers included in table above for mechanical and electrical components subject to Special Inspection for seismic resistance. Component and attachment testing shall be in accordance with applicable provisions of IBC Section 1705.12. Seismic testing and certification is in addition to functional and performance testing required for new equipment for field quality control or start-up testing as indicated in equipment technical specification.

B. Mechanical and electrical components listed in the table above shall be certified on the 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 7-05 Section 13.2.5 and Section 13.2.6, respectively.

3.04 SUPPLEMENTS

A. The supplements listed below, following “End of Section,” are a part of this Specification:

1. Contractor’s Statement of Responsibility.
2. Component Manufacturer’s Seismic Certificate of Compliance.

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 seismic force-resisting systems and for components including architectural, mechanical, and electrical components, as listed in Statement of Special Inspections (Plan) on Drawings, and that:

1. I, (We) are responsible for implementation of the Statement of Special Inspections (Plan) for the construction of the following systems:

Facility	Lateral Force-Resisting System
Chemical Storage Tanks	Flat-bottom, Ground-supported, Reinforced Nonsliding Base, Concrete Tank
Powdered Activated Carbon Storage	Foundation Slab

2. and I, (We) are responsible for construction of the following components:

Facility	Component
Chemical Storage Tanks	Purate and Sulfuric Acid Tanks
Powdered Activated Carbon Storage	Powdered Activated Carbon Storage And Feed System

3. Control of this Work will be exercised to obtain conformance with the Contract Documents approved by the building official.

4. Procedures to be used for exercising control of the Work, the method and frequency of reporting, and distribution of reports required under the Statement of Special Inspections (Plan) for this Project are attached.

5. I, (We) will provide 48-hour notification to Engineer and approved agency as required for structural tests and Special Inspection for this Project.

6. The following person is hereby identified as exercising control over the 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: _____

COMPONENT MANUFACTURER'S SEISMIC 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 the 2012 IBC for seismic qualification. Basis of qualification is by:

(Check Applicable)

- ☐ Shake-table Test
- ☐ Three-dimensional Shock Test
- ☐ Analytical Method
- ☐ Experience Data
- ☐ Other _____

under the 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:_____

Required mounting and anchorage details are shown on the attached Seismic Outline Drawing for the most seismically vulnerable component covered by this Certification.

Signed by:_____

Address:_____

Date:_____

Project Name: _____

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 Nursery and Landscape Association (ANLA): 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): 568-C, 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 shall include, but not be 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

PART 3 EXECUTION

3.01 TEMPORARY UTILITIES

A. Power: 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.

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 Contractor's 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. Maintain in continuous service existing oil and gas pipelines, underground power, telephone or communication cable, water mains, irrigation lines, sewers, poles and overhead power, and other utilities encountered along line of the Work, unless other arrangements satisfactory to owners of said utilities have been made.

B. Where completion of the Work requires temporary or permanent removal or relocation of existing utility, coordinate activities with owner of said utility and perform work to their satisfaction.

C. Protect, shore, brace, support, and maintain underground pipes, conduits, drains, and other underground utility construction uncovered or otherwise affected by construction operations.

D. Keep fire hydrants and water control valves free from obstruction and available for use at all times.

E. 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.

F. Notify utility offices that may be affected by construction operation at least 2 days in advance: Before exposing a utility, obtain utility owner's permission. Should service of utility be interrupted due to Contractor's operation, notify proper authority immediately. Cooperate with said authority in restoring service as promptly as possible and bear costs incurred.

G. 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.

H. Maintain original Site drainage wherever possible.

3.03 TEMPORARY CONTROLS

A. Air Pollution Control:

1. Minimize air pollution from construction operations.
2. Burning:
    a. Of waste materials, rubbish, or other debris will not be permitted on or adjacent to Site.

3. Conduct operations of dumping rock and of carrying rock away in trucks to cause a minimum of dust. Give unpaved streets, roads, detours, or haul roads used in construction area a dust-preventive treatment or periodically water to prevent dust. Strictly adhere to applicable environmental regulations for dust prevention.
4. Provide and maintain temporary dust-tight partitions, bulkheads, or other protective devices during construction to permit normal operation of existing facilities. Construct partitions of plywood, insulating board, plastic sheets, or similar material. Construct partitions in such a manner that dust and dirt from demolition and cutting will not enter other parts of existing building or facilities. Remove temporary partitions as soon as need no longer exists.

B. 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. Temporary Storage Yards: Construct temporary storage yards for storage of products that are not subject to damage by weather conditions.

3.05 PARKING AREAS

A. Control vehicular parking to preclude interference with parking, access by emergency vehicles, 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 SUMMARY OF WORK

A. This section covers Work necessary for stabilization of soil to prevent erosion during construction and land disturbing activities. The minimum areas requiring soil erosion and sediment control measures are indicated on the Drawings. Engineer reserves right to modify use, location, and quantities of soil erosion and sediment control measures based on activities of Contractor.

1.02 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. D3776/D3776M, Standard Test Methods for Mass Per Unit Area (Weight) of Fabric.
   c. D4355, Standard Test Method for Deterioration of Geotextiles by Exposure to Light, Moisture and Heat in Xenon Arc Type Apparatus.
   d. D4632, Standard Test Method for Grab Breaking Load and Elongation of Geotextiles.
2. Federal Emergency Management Agency (FEMA).
3. U.S. Department of Agriculture: Urban Hydrology for Small Watersheds; Soil Conservation Service Engineering Technical Release No. 55, 1986.
4. U.S. Environmental Protection Agency:
   a. Guidelines for Erosion and Sedimentation Control Planning.
   b. Implementation, Processes, Procedures, and Methods to Control Pollution Resulting from all Construction Activity.
   c. Erosion and Sediment Control Surface Mining in Eastern United States.
5. U.S. Weather Bureau: Rainfall Frequency Atlas of the United States for Durations from 30 Minutes to 24 Hours and Return Periods from 1 to 100 Years, Technical Paper No. 40, 1981.
6. Georgia Soil and Water Conservation Commission “Manual for Erosion and Sediment Control in Georgia,” Latest Edition.
7. Georgia Department of Transportation “Standard Specifications for Construction of Transportation Systems”, Latest Edition.

1.03 SYSTEM DESCRIPTION

A. Erosion and Sediment Control: Provide, maintain, and operate temporary facilities to control erosion and sediment releases, and to protect the Work and existing facilities during construction period.

B. Soil erosion stabilization and sedimentation control consists of the following elements:

1. Construction of temporary erosion control facilities such as silt fences and check dams.
2. Placement and maintenance of temporary seeding on areas disturbed by construction.

C. Activities shall conform to the “Manual for Erosion and Sediment Control in Georgia,” latest edition (referred to in this Specification as “Manual”), county Site Plan Permit, and Drawings. In the event of a conflict, the more stringent requirement shall apply.

1.04 SUBMITTALS

A. Informational Submittals:

1. Erosion/Sedimentation Control Plan identifying any field changes.
2. Sequence and schedule of activities as it relates to Erosion and Sediment Control.
3. Method for placement of soil stabilization seed and additives.

1.05 QUALITY ASSURANCE

A. Water pollution control shall comply with procedures outlined in U.S. Environmental Protection Agency manuals entitled, “Guidelines for Erosion and Sedimentation Control Planning” and “Implementation, Processes, Procedures, and Methods to Control Pollution Resulting from all Construction Activity,” and “Erosion and Sediment Control Surface Mining in Eastern United States”.

PART 2 PRODUCTS

2.01 SILT FENCE

A. Georgia Department of Transportation Type-A silt fence.

2.02 ORANGE BARRIER FENCE

A. Fabric:

1. Ultraviolet stabilized polyethylene, polypropylene, or nylon filaments woven into uniform pattern, with distinct and measurable openings.
2. Minimum Physical Qualities:
   a. Tensile Yield: Average 2,000 pounds per 4-foot width; ASTM D638.
   b. Ultimate Tensile Yield: Average 2,900 pounds per 4-foot width; ASTM D638.
   c. Elongation at Break: Greater than 1,000 percent; ASTM D638.
   d. Chemical Resistance: Inert to most chemicals and acids.
3. Color: Yellow or orange.
4. Height: 3 feet.
5. Material Edges: Finished in order that filaments retain their relative positions under stress.

B. Posts: Conventional metal “T” or “U” posts.

2.03 SOIL STABILIZATION SEEDING AND SODDING

A. Grass Type: Common Bermuda.

B. Fertilizer:

1. Commercial, chemical type, uniform in composition, free-flowing, conforming to state and federal laws, and suitable for application with equipment designed for that purpose.
2. Minimum Percentage of Plant Food by Weight:
   a. Nitrogen: 10 percent.
   b. Phosphoric Acid: 10 percent.
   c. Potash: 10 percent.

C. Lime:

1. Ground dolomitic limestone, not less than 85 percent total carbonates and magnesium, ground in order that 50 percent passes through 100-mesh sieve and 90 percent passes a 20-mesh sieve.
2. Coarser material will be acceptable provided specified rate of application is increased proportionately on basis of quantities passing 100-mesh sieve.

2.04 STRAW MULCH

A. Clean salt hay or threshed straw of oats, wheat, barley, or rye; free from seed of noxious weeds.

2.05 STRAW BALES

A. Materials:

1. Clean salt hay or straw of oats, wheat, barley, or rye free from seed of noxious weeds; machine baled using standard baling wire or string.
2. Posts for Straw Bales: 2-inch by 2-inch untreated wood or commercially manufactured metal posts.

PART 3 EXECUTION

3.01 PREPARATION

A. Engineer's acceptance of Erosion/Sedimentation Control Plan required prior to starting earth disturbing activities.

B. Contractor shall be responsible for phasing Work in areas allocated for their exclusive use during Project, including proposed stockpile areas and installation of temporary erosion control devices, ditches, or other facilities.

C. Areas set aside for Contractor's use during Project may be temporarily developed to provide satisfactory working, staging, and administrative areas. Preparation of these areas shall be in accordance with other requirements contained within Specifications and completed in a manner to control sediment transport away from area.

3.02 SILT FENCE INSTALLATION

A. Install prior to starting earth disturbing activities.

B. Construct in accordance with manufacturer's instructions.

C. Install geotextile in one piece, or continuously sewn to make one piece, for full length and height of fence, including portion of geotextile buried in toe trench. Take precaution not to puncture geotextile during installation.

D. Install bottom edge of sheet in toe trench and backfill in a way that securely anchors geotextile in trench.

E. Securely fasten geotextile to wire mesh backing and each support post in a way that will not result in tearing of geotextile when fence is subjected to service loads.

F. When joints are necessary, splice geotextile together only at support post, with a minimum 6-inch overlap, and securely fasten both ends to support post.

G. Geotextile shall not extend more than 34 inches above ground surface. Securely fasten to upslope side of each support post using ties. Do not staple geotextile to existing trees.

H. Remove after upslope area has been permanently stabilized.

3.03 SEEDING AND SODDING

A. General:

1. The Contractor shall give at least 3 days' notice to the Engineer prior to seeding and sodding 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. 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, Contractor 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.

C. Topsoil and Permanent Seeding and Sodding:

1. Topsoil and permanent seeding and sodding 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 of sod.
   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. 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.
5. Guarantee: 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.

3.04 STRAW BALES

A. Embed minimum of 4 inches in flat-bottom trench.

B. Place with ends tightly abutting or overlapped. Corner abutment is not acceptable.

C. Install in order that bale bindings are oriented around sides and not over top and bottom of bale.

D. Use two posts for each bale. Drive posts through bale until top of post is flush with top of bale.

E. Wedge loose straws in gaps between bales.

3.05 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.

3.06 FIELD QUALITY CONTROL

A. Conduct inspections with Engineer to evaluate conformance to requirements of Specifications.

B. Replace or repair failed or overloaded silt fences, or other temporary erosion control devices within 2 days after receiving written notice from Engineer.

3.07 MAINTENANCE

A. Silt Fence:

1. Silt fence shall be installed in accordance with the Manual. When backup support is used, use steel wire with a maximum mesh spacing of 2 inches by 4 inches, or plastic mesh as resistant to ultraviolet radiation as the geotextile it supports. Provide wire or plastic mesh with strength equivalent to or greater than as required for unsupported geotextile (for example, 180 pounds grab tensile strength in the machine direction).
2. Attach geotextile to posts and support system using staples, wire, or in accordance with manufacturer's recommendations. Geotextile shall be sewn together at the point of manufacture, or at a location approved by Engineer, to form geotextile lengths as required.
3. Provide wood or steel support posts at sewn seams and overlaps and as shown on the Drawings and necessary to support fence.
4. Wood Posts: Minimum dimensions of 1-1/4-inch by 1-1/4-inch by the minimum length shown on the Drawings.
5. Steel Posts: Minimum weight of 0.90 lb/ft.
6. When sediment deposits reach approximately one-third the height of the silt fence, remove and stabilize deposits.

B. Provide and maintain soil stabilization seeding at all times.

C. Silt Traps:

1. Clean silt traps of collected sediment after every storm or as determined from biweekly inspections.
2. Perform cleaning in a manner that will not direct sediment into storm drain piping system.
3. Take removed sediment to area selected by Engineer where it can be cleaned of sticks and debris, then allowed to dry.
4. Dispose of final sediment onsite as designated by Engineer.
5. Dispose of debris offsite.

D. Inspect, repair, and replace as necessary erosion control measures during the time period from start of construction to completion of construction.

E. If Contractor has not complied with above maintenance efforts to satisfaction of Engineer within 2 working days after receiving written notification from Engineer, Owner will have prerogative of engaging others to perform needed maintenance or cleanup, including removal of accumulated sediment, at Contractor's expense.

3.08 REMOVAL

A. When Engineer determines that an erosion control BMP is no longer required, remove BMP and all associated hardware from the Project limits. When materials are biodegradable, Engineer may approve leaving temporary BMP in place.

B. Permanently stabilize all bare and disturbed soil after removal of erosion and sediment control BMPs. Dress sediment deposits remaining after BMPs have been removed to conform to existing grade. Prepare and seed graded area. If installation and use of erosion control BMPs have compacted or otherwise rendered soil inhospitable to plant growth, such as construction entrances, take measures to rehabilitate soil to facilitate plant growth. This may include, but is not limited to, ripping the soil, incorporating soil amendments, or seeding with specified seed.

END OF SECTION

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. Special bonds, Special Guarantees, and Service Agreements.
   c. Consent of Surety to Final Payment: As required in General Conditions.
   d. Releases or Waivers of Liens and Claims: As required in General Conditions.
   e. Releases from Agreements.
   f. Final Application for Payment: Submit in accordance with procedures and requirements stated in Section 01 29 00, Payment Procedures.
   g. 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. 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 Addenda and 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. Broom clean exterior paved driveways and parking areas.
5. Hose clean sidewalks, loading areas, and others contiguous with principal structures.
6. Rake clean all other surfaces.
7. Remove snow and ice from access to buildings.
8. Replace air-handling filters and clean ducts, blowers, and coils of ventilation units operated during construction.
9. 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: 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 not less than 30 days prior to equipment or system field functional testing.

1.04 DATA FORMAT

A. Prepare preliminary and final data in the form of an instructional manual. In addition, provide final data on electronic format.

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.

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):
    a. After all preliminary data has been found to be acceptable to Engineer, submit Operation and Maintenance data in PDF format on CD.
    b. Files to be exact duplicates of Engineer-accepted preliminary data. Arrange by specification number and name.
    c. Files to be fully functional and viewable in most recent version of Adobe Acrobat.

1.05 SUBMITTALS

A. Informational:

1. Preliminary Data:
    a. Submit two copies for Engineer's review.
    b. If data meets conditions of the Contract:
        1) One copy will be returned to Contractor.
        2) One copy will be forwarded to Resident Project Representative.

c. If data does not meet conditions of the Contract:
   1) All copies will be returned to Contractor with Engineer's comments (on separate document) for revision.
   2) Engineer's comments will be retained in Engineer's file.
   3) Resubmit two copies revised in accordance with Engineer's comments.

2. Final Data: Submit two copies in hard-copy format specified herein plus one copy in electronic format.

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 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. Format:
      1) Provide reinforced, punched, binder tab; bind in with text.
      2) Reduced to 8-1/2 inches by 11 inches, or 11 inches by 17 inches folded to 8-1/2 inches by 11 inches.
      3) Where reduction is impractical, fold and place in 8-1/2-inch by 11-inch envelopes bound in text.
      4) Identify Specification section and product on Drawings and envelopes.

b. Relations of component parts of equipment and systems.
c. Control and flow diagrams.
d. 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. Each Maintenance Summary may take as many pages as required.
    b. Use only 8-1/2-inch by 11-inch size paper.
    c. 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.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

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), as amended by the State of Georgia.
4. Fayette County, GA Code of Ordinances

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 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.
3. Design attachments, braces, and anchors for equipment, components, and distribution systems to structure for gravity, seismic, wind, and operational loading.
4. Piping and ductwork, whether exempt or not exempt for this section, shall be anchored and braced so that lateral or vertical displacement does not result in damage or failure to essential architectural, mechanical, or electrical equipment.
5. 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.
6. Provide supplementary framing where required to transfer anchorage and bracing loads to structure.
7. Adjust equipment pad sizes or provide additional anchorage confinement reinforcing to provide required anchorage capacities.
8. 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.
9. Design seismic anchorage and bracing for Designated Seismic Systems regardless of weight or mounting height.
    a. Component Important Factor:
        1) Ip = 1.0, unless noted otherwise.
        2) Ip 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 33, Special Inspection, Observation and Testing, for list of designated components which Ip equals 1.5.

10. 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, 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 as applicable for Project Seismic Design Category.

C. Seismic Design Requirements:

1. Nonstructural Components: Design as non-building 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 Ip = 1.5.

3. Support drawings and calculations for electrical distribution components shall be provided if any of the following conditions apply:
    a. Ip is equal to 1.5 and conduit diameter is greater than 2.5-inch trade size.
    b. Ip is equal to 1.5 and the total weight of bus duct, cable tray, or conduit supported by trapeze assemblies exceeds 10 pounds per foot.
    c. Supports are cantilevered up from floor.
    d. Supports include bracing to limit deflection and are constructed as rigid welded frames.
    e. Attachments utilize spot welds, plug welds, or minimum size welds as defined by AISC.
4. Other seismic design and detailing requirements identified in ASCE 7 Chapter 13 are required to be provided for new 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 hardware product data.
    c. Seismic attachment assemblies' drawings; include connection hardware, braces, and anchors or anchor bolts for nonexempt components, equipment, and systems.
    d. Submittal will be rejected if proposed anchorage method would create an overstressed condition of supporting member. Revise anchorages and strengthening of structural support so there is no 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 or structural 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 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 on Drawings and Section 01 45 33, Special Inspection, Observation, and Testing.

B. All other specified, regulatory required, or repair verification inspection and testing that are not listed in Statement of Special Inspections, are to be provided by Contractor and shall meet requirements of Section 01 45 16.13, Contractor Quality Control.

C. Source Quality Control for shall be in accordance with Section 05 50 00, Metal Fabrications.

PART 2 PRODUCTS

2.01 GENERAL

A. Attachments and supports transferring seismic loads to structure shall be designed and constructed of materials and products suitable for application and be in accordance with design criteria shown on Drawings and nationally recognized standards.

B. Provide anchor bolts and concrete and masonry anchors for anchorage of equipment to concrete or masonry in accordance with Section 05 50 00, Metal Fabrications. Size of anchor bolts and anchors, required minimum embedment, and spacing shall be based on calculations submitted by Contractor.

C. 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 non-vibration 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. Overall seismic anchorage system shall provide restraint in all directions, including vertical, for each component or system so anchored.

C. Components mounted on vibration isolation systems shall have snubbers in each horizontal direction and vertical restraints where required to resist overturning.

D. Anchor piping in such a manner as to ensure piping system has adequate 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.

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 CONTROL

A. In accordance with Section 05 50 00, Metal Fabrications.

B. Contractor responsibilities to accommodate Owner-furnished special inspections and testing are provided in Project's Statement of Special Inspections on Drawings and Section 01 45 33, Special Inspection, Observation, and Testing.

END OF SECTION

SECTION 01 91 14
EQUIPMENT TESTING AND FACILITY STARTUP

PART 1 GENERAL

1.01 DEFINITIONS

A. Facility: Entire Project, or an agreed-upon portion, including all of its unit processes.

B. 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.

C. 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.

D. Unit Process: As used in this section, a unit process is a portion of the facility that performs a specific process function, such as powdered activated carbon system, chlorine dioxide, and filter system.

E. Facility Performance Demonstration:

1. A demonstration, conducted by Contractor, with assistance of Owner, to demonstrate and document the performance of the entire operating facility, both manually and automatically (if required), based on criteria developed in conjunction with Owner and as accepted by Engineer.
2. Such demonstration is for the purposes of (i) verifying to Owner entire facility performs as a whole, and (ii) documenting performance characteristics of completed facility for Owner's records. Neither the demonstration nor the evaluation is intended in any way to make performance of a unit process or entire facility the responsibility of Contractor, unless such performance is otherwise specified.

1.02 SUBMITTALS

A. Informational Submittals:

1. Facility Startup and Performance Demonstration Plan.
2. Functional and performance test results.
3. Completed Unit Process Startup Form for each unit process.
4. Completed Facility Performance Demonstration/Certification Form.

1.03 FACILITY 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 each unit process and the complete facility.

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.
3. Facility Performance Demonstration/Certification Form (sample attached), to minimally include the following:
   a. Description of unit processes included in the facility startup.
   b. Sequence of unit process startup to achieve facility startup.
   c. Description of computerized operations, if any, included in the facility.
   d. Contractor certification facility is capable of performing its intended function(s), including fully automatic operation.
   e. Signature spaces for Contractor and Engineer.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 GENERAL

A. Facility 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 facility 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, including items to be furnished by Owner.
    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. Startup sequencing of unit processes shall be as chosen by Contractor to meet schedule requirements.

C. Make adjustments, repairs, and corrections necessary to complete unit process startup.

D. Startup shall be considered complete when, in opinion of Engineer, unit process has operated in manner intended for 7 continuous days without significant interruption. This period is in addition to functional or performance test periods specified elsewhere.

E. 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.

F. 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 FACILITY PERFORMANCE DEMONSTRATION

A. When, in the opinion of Engineer, startup of all unit processes has been achieved, sequence each unit process to the point that facility is operational.

B. Demonstrate proper operation of required interfaces within and between individual unit processes.

C. After facility is operating, complete performance testing of equipment and systems not previously tested.

D. Document, as defined in Facility Startup and Performance Demonstration Plan, the performance of the facility including its computer system, until all unit processes are operable and under control of computer system.

E. Certify, on the Facility Performance Demonstration/Certification Form, that facility is capable of performing its intended function(s), including fully automatic and computerized operation.

3.05 SUPPLEMENTS

A. Supplements listed below, following “End of Section,” are a part of this Specification:

1. Unit Process Startup Form.
2. Facility Performance Demonstration/Certification 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: _____

FACILITY PERFORMANCE DEMONSTRATION/CERTIFICATION FORM

OWNER: _____ **PROJECT**: _____

Unit Processes Description (List unit processes involved in facility startup): _____

_____

_____

_____

_____

Unit Processes Startup Sequence (Describe sequence for startup, including computerized operations, if any): _____

_____

_____

_____

_____

_____

_____

Contractor Certification that Facility is capable of performing its intended function(s), including fully automatic operation:

Contractor: _____ Date: _____, 20_____

Engineer: _____ Date: _____, 20_____
(Authorized Signature)

SECTION 02 41 00
DEMOLITION

PART 1 GENERAL

1.01 REFERENCES

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

1. Air-Conditioning, Heating, and Refrigeration Institute (AHRI): Guideline K, Containers for Recovered Non-flammable Fluorocarbon Refrigerants.
2. American National Standards Institute (ANSI): A10.6, Safety Requirements for Demolition Operations.
3. Occupational Safety and Health Administration (OSHA), U.S. Code of Federal Regulations (CFR) Title 29 Part 1926—Occupational Safety and Health Regulations for Construction.
4. Environmental Protection Agency (EPA), U.S. Code of Federal Regulations (CFR), Title 40:
    a. Part 61—National Emission Standards for Hazardous Air Pollutants.
    b. Part 82—Protection of Stratospheric Ozone.
    c. Part 273—Standards for Universal Waste Management.

1.02 DEFINITIONS

A. ACM: Asbestos-containing material.

B. Demolition: Dismantling, razing, destroying, or wrecking of any fixed building or structure or any part thereof.

C. Modify: Provide all necessary material and labor to modify an existing item to the condition indicated or specified.

D. 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.

E. Renovation: Altering a facility or one or more facility components in any way.

F. 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.

G. Universal Waste Lamp: In accordance with 40 CFR 273, the bulb or tube portion of an electric lighting device, examples of which include, but are not limited to, fluorescent, high-intensity discharge, neon, mercury vapor, high-pressure sodium, and metal halide lamps.

H. Universal Waste Thermostat: A temperature control device that contains metallic mercury in an ampule attached to a bimetal sensing element, and mercury-containing ampules that have been removed from these temperature control devices in compliance with the requirements of 40 CFR 273.

1.03 SUBMITTALS

A. Informational Submittals:

1. Submit proposed Demolition/Renovation Plan, in accordance with requirements specified herein, for approval before such Work is started.
2. Submit copies of any notifications, authorizations and permits required to perform the Work.

1.04 REGULATORY AND SAFETY REQUIREMENTS

A. When applicable, demolition Work shall be accomplished in strict accordance with 29 CFR 1926-Subpart T.

B. Comply with federal, state, and local hauling and disposal regulations. In addition to the requirements of the General Conditions, Contractor’s safety requirements shall conform to ANSI A10.6.

1.05 DEMOLITION/RENOVATION PLAN

A. Demolition/Renovation Plan shall provide for safe conduct of the Work and shall include:

1. Detailed description of methods and equipment to be used for each operation;
2. The Contractor’s planned sequence of operations, including coordination with other work in progress.

1.06 SEQUENCING AND SCHEDULING

A. The Work of this Specification shall not commence until Contractor’s Demolition/Renovation Plan has been approved by Engineer.

B. Include the Work of this Specification in the progress schedule, as specified in Section 01 32 00, Construction Progress Documentation.

C. Areas in which the Work is to be accomplished will be available in accordance with Section 01 31 13, Project Coordination.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 EXISTING FACILITIES TO BE DEMOLISHED OR RENOVATED

A. Facilities:

1. Structures and adjacent designated areas scheduled for complete demolition are as shown.
2. Portions of structures and other areas scheduled for selective demolition, partial demolition, and renovation Work are as shown.

B. Structures:

1. Existing above-grade structures indicated shall be removed as indicated.
2. Interior walls, other than retaining walls and partitions, shall be removed as indicated.
3. Partition walls shall be removed as shown.
4. Core drill concrete slabs and other concrete improvements scheduled to remain in place below ground, or break holes at the structure's lowest point to allow water to freely migrate through.
5. Sidewalks, curbs, gutters and street light bases shall be removed as indicated.

C. Paving and Slabs:

1. Sawcut concrete and asphaltic concrete paving and slabs as indicated.
2. Provide neat sawcuts at limits of pavement removal as indicated.

D. Masonry: Sawcut and remove masonry so as to prevent damage to surfaces to remain and to facilitate the installation of new Work. Where new masonry adjoins existing, the new Work shall abut or tie into the existing construction as indicated.

E. Concrete: 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. Do not overcut corners. Break out the remainder of the concrete provided that the broken area is concealed in the finished Work, and the remaining concrete is sound. At locations where the broken face cannot be concealed, grind smooth or saw cut entirely through the concrete. Where new concrete adjoins existing, the new Work shall abut or tie into the existing construction as indicated.

F. 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 caused by previous physical damage or left as a result of removals in existing masonry walls with an approved patching material, applied in accordance with the manufacturer's printed instructions.

G. 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. Building Occupancy: Refer to Section 01 31 13, Project Coordination, for specific requirements related to concurrent occupancy of facilities to be partially demolished.

B. 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 or hazard 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. Vacuum and dust the Work area daily.
3. Sweep pavements as often as necessary to control the spread of debris that may result in foreign object damage potential to vehicular traffic.

C. 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. Provide temporary weather protection during interval between removal of existing exterior surfaces and installation of new to ensure that no water leakage or damage occurs to structure or interior areas of existing building.
4. 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.
5. Do not overload pavements to remain.

D. Weather Protection: For portions of the building scheduled to remain, protect building interior and materials and equipment from weather at all times. Where removal of existing roofing is necessary to accomplish the Work, have materials and workmen ready to provide adequate and temporary covering of exposed areas so as to ensure effectiveness and to prevent loss.

E. Trees: Protect trees within the Site that might be damaged during demolition and are indicated to be left in place, by a 6-foot-high fence. The fence shall be securely erected a minimum of 5 feet from the trunk of individual trees or follow the outer perimeter of branches or clumps of trees. Any tree designated to remain that is damaged during the Work shall be replaced in kind, as approved by the Engineer.

F. Facilities:

1. Protect electrical and mechanical services and utilities. Where removal of existing utilities and pavement is specified or indicated, provide approved barricades, temporary covering of exposed areas, and temporary services or connections for electrical and mechanical utilities.
2. Floors, roofs, walls, columns, pilasters, and other structural elements that are designed and constructed to stand without lateral support or shoring, and are determined by Contractor to be in stable condition, shall remain standing without additional bracing, shoring, or lateral support until demolished, unless directed otherwise by the Engineer.
3. Protect all facility elements not scheduled for demolition.
4. Provide interior shoring, bracing, or support to prevent movement, settlement, or collapse of structure or element to be demolished and adjacent facilities.

G. Protection of Personnel:

1. During demolition, continuously evaluate the condition of the structure being demolished and take immediate action to protect all personnel working in and around the demolition site.
2. Provide temporary barricades and other forms of protection to protect Owner’s personnel and the general public from injury due to demolition Work.
3. 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**.** Where burning is permitted, adhere strictly to federal, state, and local regulations.

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 BACKFILL

A. Do not use demolition debris as backfill material.

B. Fill excavations, open basements and other hazardous openings to existing ground level or foundation level of new construction in accordance with Section 31 23 23, Fill and Backfill.

3.06 TITLE TO MATERIALS

A. Title to equipment and materials resulting from demolition is vested in the Contractor upon approval by Engineer of Contractor's Demolition/Renovation Plan, and the resulting authorization by Engineer to begin demolition.

3.07 DISPOSITION OF MATERIAL

A. Do not remove equipment and materials without approval of Contractor's Demolition/Renovation Plan by Engineer.

B. Salvage equipment and material to the maximum extent possible.

3.08 REUSE OF MATERIALS AND EQUIPMENT

A. Remove and store materials and equipment listed in Article Title To Materials to be reused or relocated to prevent damage, and reinstall as the Work progresses.

B. Properly store and maintain equipment and materials in same condition as when removed.

C. Store equipment and material designated to be reused in a location designated by Owner.

D. Equipment and material designated to be reused shall be cleaned, serviced and checked for proper operability before being put back into service.

E. Engineer will determine condition of equipment and materials prior to removal.

3.09 CLEANUP

A. Debris and rubbish shall be removed from basement and similar excavations. 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 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.
   b. 301, Specifications for Structural Concrete.
   c. 318, Building Code Requirements for Structural Concrete and Commentary.

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. When high range water reducer (superplasticizer) is used in concrete mix, form design shall account for increased hydrostatic pressures.

C. Joints in forms shall be watertight.

D. Limit panel deflection to 1/360th of each component span to achieve tolerances specified.

1.04 SUBMITTALS

A. Action Submittals:

1. 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 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 products approved for use on steel forms.

B. 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 Rheofinish 211.
   b. Cresset Chemical Company; Crete-Lease 20-VOC-Xtra.

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 with Water Stop: For liquid-containing structures, basements, pipe galleries, and accessible spaces below finish grade, furnish one of the following:

1. Integral steel waterstop 0.103-inch thick and 0.625-inch diameter tightly and continuously welded to tie.

2. Neoprene waterstop 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.
3. Orient waterstop perpendicular to tie and symmetrical about center of tie.
4. 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: Provide forms in accordance with ACI 117 and ACI 318, and the following tolerances for finishes specified:

1. See the Schedule of Concrete Finishes in Section 03 30 00, Cast-in-Place Concrete, for wall types related to required form tolerances.
2. Wall Tolerances:
   a. Straight Vertical or Horizontal Wall Surface: Flat planes within tolerance specified.
   b. Wall Type W-A:
      1) Plumb within 1/4 inch in 10 feet or within 1 inch from top to bottom for walls over 40 feet high.
      2) Depressions in Wall Surface: Maximum 5/16 inch when 10-foot straightedge is placed on high points in all directions.
   c. Thickness: Maximum 1/4 inch minus or 1/2 inch plus from dimension shown.
   d. Form Offset: Between adjacent pieces of formwork, facing material shall not exceed 1/4 inch.

3.03 FORM REMOVAL

A. Non-supporting 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. 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 CONTROL

A. Owner-Furnished Quality Assurance, in accordance with IBC Chapter 17 requirements, is provided in Statement of Special Inspections Plan on Drawings. 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 Billet-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.
2. Corps of Engineers (COE): CRD-C-572, Corps of Engineers Specifications for Polyvinylchloride Waterstop.
3. NSF International (NSF): 61, Drinking Water System Components - Health Effects.

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: Layout and location.

B. Informational Submittals:

1. Manufacturer's written instructions for product shipment, storage, handling, installation/application, and repair for: Waterstop.

1.03 DELIVERY, STORAGE, AND HANDLING

A. Acceptance at Site: Verify delivered materials are in accordance with Specifications 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.

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: Center bulb with parallel ribs or protrusions on each side of strip center.

F. Corrugated or tapered type waterstops are not acceptable.

G. Thickness: Constant from bulb edge to outside stop edge.

H. Minimum Weight per Foot of Waterstop: 1.60 pounds for 3/8 inch by 6 inches.

I. Factory Fabrications: Use only factory fabrications for intersections, transitions, and changes of direction.

J. Manufacturers and Products:

1. Vinylex Corp., Knoxville, TN; Catalog No. 03250/VIN: No. RB6-38H (6 inches by 3/8 inch).
2. Greenstreak Plastic Products, St. Louis, MO; Catalog No. 03150/GRD: Style 732 (6 inches by 3/8 inch).
3. Four Seasons Industries Durajoint, Garrettsville, OH; Catalog No. CSP-162: Type 9 (6 inches by 3/8 inch).

2.02 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: Rubatex Corp.; R-451-N.

2.03 ACCESSORIES

A. Nonshrink Grout: As specified in Section 03 62 00, Nonshrink Grouting.

B. Reinforcing Steel: As specified in Section 03 21 00, Reinforcing Steel.

C. Nails: Galvanized, as required for securing premolded joint filler.

D. 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 reinforcing steel 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.

3.03 INSTALLATION OF WATERSTOPS

A. General:

1. Continuous waterstop (as specified) shall be installed in all construction joints in walls and slabs of liquid containing 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 reinforcing steel using grommets, “Hog Rings,” or tiewire 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 plastic 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 waterstop to confirm full consolidation without voids, then place remaining concrete to full height of slab.

B. Plastic Waterstop:

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.

END OF SECTION

SECTION 03 21 00
REINFORCING STEEL

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 and Commentary.
   b. SP-66, Detailing Manual.
2. American Welding Society (AWS): D1.4/D1.4M, Structural Welding Code - Reinforcing Steel.
3. ASTM International (ASTM):
   a. A82/A82M, Standard Specification for Steel Wire, Plain, for Concrete Reinforcement.
   b. A185/A185M, Standard Specification for Steel Welded Wire Reinforcement, Plain, for Concrete.
   c. A497/A497M, Standard Specification for Steel Welded Wire Reinforcement, Deformed, for Concrete.
   d. A615/A615M, Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
   e. A706/A706M, Standard Specification for Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement.
   f. A767/767M, Standard Specification for Zinc-Coated (Galvanized) Steel bars for Concrete Reinforcement
   g. A775/A775M, Standard Specification for Epoxy-Coated Steel Reinforcing Bars.
4. Concrete Reinforcing Steel Institute (CRSI):
   a. Placing Reinforcing Bars.
   b. Manual of Standard Practice.
5. International Code Council (ICC): Evaluation Services Report.
6. Wire Reinforcement Institute (WRI): WWR-500, Manual of Standard Practice, Structural Welded Wire Reinforcement.

1.02 SUBMITTALS

A. Action Submittals:

1. Shop Drawings prepared in accordance with CRSI Manual of Standard Practice and ACI SP-66:
   a. Bending lists.
   b. Placing Drawings.

B. Informational Submittals: Lab test reports for reinforcing steel showing stress-strain curves and ultimate strengths.

1.03 DELIVERY, STORAGE, AND HANDLING

A. Unload, store, and handle bars in accordance with CRSI publication “Placing Reinforcing Bars.”

PART 2 PRODUCTS

2.01 MATERIALS

A. Reinforcing Bars:

1. Includes stirrups, ties, and spirals.
2. ASTM A615/A615M, Grade 60.

2.02 ACCESSORIES

A. Tie Wire: Black, soft-annealed 16-gauge wire.

B. Bar Supports and Spacers:

1. Use precast concrete bar supports and 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 reinforcing steel.
5. In Walls, and Slabs Exposed to View after Form Removal: Use small precast concrete blocks made of same color as concrete in which they are embedded**.** All-plastic bar supports and side form spacers may be used, except where surface is exposed as described above.

6. Design and fabricate special bar supports for top reinforcing bars in slabs where standard bar supports do not possess necessary geometry, strength, or stiffness.

2.03 FABRICATION

A. Follow CRSI Manual of Standard Practice.

B. Bend bars cold.

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.

3.02 INSTALLATION

A. Bundle or space bars, instead of field bending where construction access through reinforcing is necessary.

B. Spacing and Positioning: Conform to ACI 318.

C. Location Tolerances: In accordance with CRSI publication, “Placing Reinforcing Bars”.

D. Splicing:

1. Follow ACI 318.
2. Use lap splices, unless otherwise shown or permitted in writing by Engineer.

E. 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.

F. 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.

G. Straightening and Rebending: Field bending of reinforcing steel bars is not permitted.

H. Unless permitted by Engineer, do not cut reinforcing bars in field.

3.03 TESTS AND INSPECTION

A. Special inspection will be provided by Owner as indicated on Drawings.

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. C979/C979M, Standard Specification for Pigments for Integrally Colored Concrete.
q. C989, Standard Specification for Slag Cement for Use in Concrete and Mortars.
r. C1012/C1012M, Standard Test Method for Length Change of Hydraulic-Cement Mortars Exposed to a Sulfate Solution.
s. C1017/C1017M, Standard Specification for Chemical Admixtures for Use in Producing Flowing Concrete.
t. C1074, Standard Practice for Estimating Concrete Strength by the Maturity Method.
u. C1077, Standard Practice for Agencies Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Testing Agency Evaluation.
v. C1218/C1218M, Standard Test Method for Water-Soluble Chloride in Mortar and Concrete.
w. C1240, Standard Specification for Silica Fume Used in Cementitious Mixtures.
x. C1260, Standard Test Method for Potential Alkali Reactivity of Aggregates (Mortar-Bar Method).
y. C1293, Standard Test Method for Determination of Length Change of Concrete Due to Alkali-Silica Reaction.
z. C1567, Standard Test Method for Determining the Potential Alkali-Silica Reactivity of Combinations of Cementitious Materials and Aggregate (Accelerated Mortar-Bar Method).
aa. C1582/C1582M, Standard Specification for Admixtures to Inhibit Chloride-Induced Corrosion of Reinforcing Steel in Concrete.
bb. C1602/C1602M, Standard Specification for Mixing Water Used in the Production of Hydraulic Cement Concrete.
cc. D4580, Standard Practice for Measuring Delaminations in Concrete Bridge Decks by Sounding.
dd. E329, Standard Specification for Agencies Engaged in Construction Inspection, Special Inspection, or Testing Materials Used in Construction.
ee. E1155, Standard Test Method for Determining F_F Floor Flatness and F_L Floor Levelness Numbers.

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, 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:
1) Cement: Chemical analysis report.
2) Supplementary Cementitious Materials: Chemical analysis report and report of other specified test analyses.
3) 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.
4) Shrinkage Test Results: In accordance with ASTM C157/C157M as modified herein.

e. Aggregates:
1) Coarse Aggregate Gradation: List gradings and percent passing through each sieve.
2) Fine Aggregate Gradation: List gradings and percent passing through each sieve.
3) Combined gradation for coarse and fine aggregates. List gradings and percent passing through each sieve.
4) Deleterious substances in fine aggregate per ASTM C33/C33M, Table 2.
5) Deleterious substances in coarse aggregate per ASTM C33/C33M, Table 4.
6) Test Reports:
a) Alkali Aggregate Reactivity: Aggregate shall be classified as not potentially 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.
5. Concrete repair techniques.

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:
   a. Bonding agent.
   b. Repair materials.
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.
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-μm (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.
7. Do not use calcium chloride as an admixture.

D. Water and Ice: Mixing water for concrete and water used to make ice shall be potable water, unless alternative sources of water are permitted.

1. Water from alternative sources shall comply with requirements of ASTM C1602/C1602M, and concentration of chemicals in combined mixing water shall be less than:
   a. Chloride Content: 1,000 ppm.
   b. Sulfate Content as SO_4: 3,000 ppm.
   c. Alkalis as (Na_2O + 0.658 K_2O): 600 ppm.
   d. Total Solids by Mass: Less than 50,000 ppm.

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.

B. Repair Material:

1. Contain only trace amounts of chlorides and other chemicals that can potentially cause steel to oxidize.
2. Where repairs of exposed concrete are required, prepare mockup using proposed repair materials and methods, for confirmation of appearance compatibility prior to use.
3. Obtain Manufacturer's Certificate of Compliance that products selected are appropriate for specific applications.
4. Repair mortar shall be Site mixed.
5. Prepare concrete substrate and mix, place, and cure repair material in accordance with manufacturer's written recommendations.
6. Manufacturers and Products:
   a. BASF Building Systems Inc., Shakopee, MN; EMACO S-Series products.
   b. Sika Chemical Corp., Lyndhurst, NJ; SikaTop-Series.

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 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. Use low-alkali cement or incorporate pozzolans into concrete mixture as necessary to satisfy testing for potential alkali 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. Concrete Shrinkage Limits: Where shrinkage limits are specified, design mix for following shrinkage limits and test in accordance with ASTM C157/C157M, with the following modifications:

1. Prisms shall be moist cured for 7 days prior to 28-day drying period.
2. Comparator reading at end of 7-day moist cure shall be used as initial length in length change calculation.
3. Reported results shall be average of three prisms.

4. If shrinkage of a specimen departs from average of that test age by more than 0.004 percent, disregard results obtained from that specimen.
5. Unless otherwise specified, results at end of 28-day drying period shall not exceed 0.040 percent if 3-inch prisms are used, or exceed 0.038 percent if 4-inch prisms are used. Aggregate will be rejected if test values exceed these limits.

E. 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.

F. Combined Aggregate Gradation:

1. Combined Gradation Limits: Limits shown are for coarse aggregates and fine aggregates mixed together (combined). Select one of the gradations shown in the following table:

	Combined Gradation Percentage Passing		
Sieve Sizes	**1-1/2" Max.**	**1" Max.**	**3/4" Max.**
2"	100	-	-
1-1/2"	95 - 100	100	-
1"	65 - 85	90 - 100	100
3/4"	55 - 75	70 - 90	92 - 100
1/2"	-	-	68 - 86
3/8"	40 - 55	45 - 65	57 - 74
No. 4	30 - 45	31 - 47	38 - 57
No. 8	23 - 38	23 - 40	28 - 46
No. 16	16 - 30	17 - 35	20 - 36
No. 30	10 - 20	10 - 23	14 - 25
No. 50	4 - 10	2 - 10	5 - 14
No. 100	0 - 3	0 - 3	0 - 5
No. 200	0 - 2	0 - 2	0 - 2

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. Reinforcement: Secure in position before placing concrete.
2. 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.
3. Placement frequency shall be such that lift lines will not be visible in exposed concrete finishes.
4. Use placement devices, for example chutes, pouring spouts, and pumps as required to prevent segregation.
5. 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.

6. 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.
7. Do not use aluminum conveying devices.
8. Provide sufficient illumination in the interior of forms so concrete deposition is visible, permitting confirmation of consolidation quality.
9. 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.
10. Trowel and round off top exposed edges of walls with 1/4-inch radius steel edging tool.
11. 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. 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. Uniformly space vertical construction joints within straight sections of walls and slabs, avoiding penetrations.
3. Should placement sequence result in cold joint located below finished water surface, install waterstop in joint.

H. Minimum Time between Adjacent Placements:

1. Construction 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. For columns and walls 10 feet in height or less, wait at least 1 hour prior to depositing concrete in beams, girders, brackets, column capitals, or slabs supported thereon.

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. 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.
3. 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 cracks that leak with crack repair epoxy.
2. Repair defective areas of concrete.
3. Repair concrete surfaces using specified materials. Select system, submit for review, and obtain approval from Engineer prior to use.
4. Develop repair techniques with material manufacturer on surface that will not be visible in final construction prior to starting actual repair work and show how finish color will blend with adjacent surfaces. Obtain approval from Engineer.
5. Obtain quantities of repair material and manufacturer's detailed instructions for use to provide repair with finish to match adjacent surface or apply sufficient repair material adjacent to repair to blend finish appearance.
6. Repair of concrete shall provide structurally sound surface finish, uniform in appearance or upgrade finish by other means until acceptable to Engineer.

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-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.

B. Type W-5 (Finish for Coating):

1. In accordance with requirements for Type W-2 except as follows: Leave surface ready for coating as specified in Section 09 96 35, Chemical Resistant Coatings.

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-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.

C. 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.

D. 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.

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.

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, and shrinkage specimens (ASTM C157/C157M) 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. Concrete with specified 56-day strength, test one specimen at age of 7 days for information, two 6-inch diameter or when permitted three 4-inch diameter test specimens at age of 28 days for acceptance, and two 6-inch diameter or when permitted three 4-inch diameter test specimens at age of 56 days for acceptance. Should results of 28-day tests meet specified requirement for 56-day strength, 56-day tests will not be required.
3. 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.
4. 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: Chlorine Dioxide Containment Structures.
3. Water for initial tightness test shall be provided by Contractor.
4. After testing has been completed, dispose of test water in a manner approved by Owner.
5. 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.
6. Measure water surface at two points 180 degrees apart when possible where attachments, such as ladders exist, at 24-hour intervals.
7. 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.
8. Repairs When Test Fails:
   a. Dewater structure; fill leaking cracks with crack repair epoxy. Repair method shall be approved by Engineer.
   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. 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
Walls to receive coatings	W-5	W-B
Exterior Slabs		
Liquid-containing tanks and basins/top of wall	S-2	S-B
Top of footing	S-2	S-A
Sidewalks	S-6	S-B

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 5000F3S1P2C2.
2. Concrete Mix Design, Class 4500F3S1P1C2.

END OF SECTION

CONCRETE MIX DESIGN, CLASS 5000F3S1P2C2

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 4,000 psi at 28 days and 5,000 psi at 56 days.
3. Designed to conform to shrinkage limits.
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 3,500 psi at 28 days and 4,500 psi at 56 days.
3. 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.

4. 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.
All 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.

5. 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.

6. 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.
3. NSF International: 61, Drinking Water System Components – Health Effects.

1.02 SUBMITTALS

A. Action Submittals:

1. Manufacturers' data indicating compliance with the requirements specified herein for the following products:
   a. Evaporation retardant.
   b. Curing compound.
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, for the following: Curing compound showing moisture retention requirements.

PART 2 PRODUCTS

2.01 MATERIALS

A. Curing Compound:

1. Water-based, high-solids content, non-yellowing, curing compound meeting requirements of ASTM C1315 Type I, Class A.

2. Manufacturers and Products:
    a. BASF Construction Chemicals, Shakopee, MN; Kure 1315.
    b. Euclid Chemical Co., Cleveland, OH; Super Diamond Clear VOX.
    c. WR Meadows, Inc., Hampshire, IL; VOCOMP-30.
    d. Vexcon Chemical, Inc.; Philadelphia, PA; Starseal 1315.
    e. Dayton Superior; Safe Cure and Seal 1315 EF.
    f. BASF Construction Chemicals, Shakopee, MN; Kure-N-Seal.
    g. Euclid Chemical Co., Cleveland, OH; EucoCure VOX.
    h. Euclid Chemical Co., Cleveland, OH; Kurez VOX.

B. Evaporation Retardant:

1. Optional: Fluorescent fugitive dye color tint that disappears completely upon drying.
2. Manufacturers and Products:
    a. Master Builders Co., Cleveland, OH; Confilm.
    b. Euclid Chemical Co., Cleveland, OH; Eucobar.

C. Water: Clean and potable, containing less than 500 ppm of chlorides.

PART 3 EXECUTION

3.01 CONCRETE CURING

A. General:

1. Where surfaces are to receive coatings, painting, cementitious material, or other similar finishes, use only water curing procedures. Refer to Drawings for surfaces to receive coatings.
2. 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.
3. 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. Walls:
    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. Slabs and Curbs:
   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.

END OF SECTION

SECTION 03 62 00
NONSHRINK 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. C621, Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrinkable).
   c. C939, Standard Test Method for Flow of Grout for Preplaced-Aggregate Concrete (Flow Cone Method).
   d. C1107/C1107M, Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink).

1.02 SUBMITTALS

A. Action Submittals:

1. Product data of grouts.
2. Proposed method for keeping existing concrete surfaces wet prior to placing grout.
3. Forming method for fluid grout placements.
4. Curing method for grout.

B. Informational Submittals:

1. Manufacturer’s Written Instructions: Mixing of grout.

1.03 QUALIFICATIONS

A. Nonshrink 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.

1.04 GUARANTEE

A. Manufacturer’s guarantee shall not contain disclaimer on the product data sheet, grout bag, or container limiting responsibility to only the purchase price of products and materials furnished.

B. Manufacturer guarantees participation with Contractor in replacing or repairing grout found defective as a result of faulty materials, as determined by industry standard test methods.

PART 2 PRODUCTS

2.01 NONSHRINK GROUT SCHEDULE

A. Furnish nonshrink grout for applications in grout category in the following schedule:

Application	Temperature Range	Max. Placing Time	
	40 deg F to 100 deg F	20 Min.	Greater Than 20 Min.
Filling through bolt holes	I	I	I
Machine bases 25 hp or less	II	II	II

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 Systems, Inc., Shakopee, MN; Construction Grout.
   b. Euclid Chemical Co., Cleveland, OH; NS Grout.
   c. Dayton Superior Corp., Kansas City, KS; 1107 Advantage Grout.
   d. US MIX Co., Denver, CO; US Spec MP Grout.
   e. L & M Construction Chemicals, Inc., Omaha, NE; Duragrout.

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 100 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 to 9 yard loads in ready-mix truck.
8. Manufacturers and Products:
   a. BASF Building Systems, Inc., Shakopee, MN; Master Flow 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., Kansas City, KS; Sure Grip High Performance Grout.
   e. L & M Construction Chemicals, Inc., Omaha, NE; Crystex.

PART 3 EXECUTION

3.01 NONSHRINK GROUT

A. General: Mix, place, and cure nonshrink grout in accordance with grout manufacturer's representative's training instructions.

B. Through-Bolt Holes: Provide nonshrink grout, Category I and 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.

C. Grouting Machinery Foundations:

1. 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.
2. Set machinery in position and wedge to elevation with steel wedges, or use cast-in leveling bolts.

3. Form with watertight forms at least 2 inches higher than bottom of plate.
4. Fill space between bottom of machinery base and original concrete in accordance with manufacturer's representative's training instructions.

3.02 FIELD QUALITY CONTROL

A. Evaluation and Acceptance of Nonshrink Grout:

1. Provide a flow cone and cube molds with restraining plates onsite. Continue tests during Project as demonstrated by grout manufacturer's representative.
2. 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.
3. 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.
4. Consistency: As specified in Article Nonshrink Grout. Grout with consistencies outside range requirements shall be rejected.
5. Segregation: As specified in Article Nonshrink Grout. Grout when aggregate separates shall be rejected.
6. Nonshrink grout cubes shall test equal to or greater than minimum strength specified.
7. Strength Test Failures: Nonshrink grout work failing strength tests shall be removed and replaced.
8. Perform bleeding test to demonstrate grout will not bleed.
9. Store cubes at 70 degrees F.
10. Independent testing laboratory shall prepare, store, cure, and test cubes in accordance with ASTM C1107/C1107M.

END OF SECTION

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. 2012International 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.

1.03 SUBMITTALS

A. Action Submittals:

1. Product Data: Manufacturer’s catalog information.

B. Informational Submittals:

1. Manufacturer’s qualifications; include client name, address, contact person, phone number, project location, and description of work.
2. Manufacturer’s instructions for preparation, placement, drilling of holes, installation of anchors and adhesive, and handling of cartridges, nozzles, and equipment.
3. Manufacturer’s written letter of certification identifying installer’s qualifications to install products.
4. 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 runout.
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 or HIT-HY 150 MAX-SD Adhesive Anchors.

b. Powers Fasteners, Brewster, NY; Power PE1000+ Epoxy Adhesive Anchor System (1/2-inch to 7/8-inch diameter anchors).
c. Simpson Strong-Tie Co., Inc., Pleasanton, CA; SET-XP Epoxy Adhesive Anchors.

B. Mixing Nozzles: Disposable, manufactured in several sizes to accommodate size of reinforcing dowels.

C. Reinforcing Dowels: As specified in Section 03 21 00, Reinforcing Steel.

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 reinforcing steel 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 reinforcing steel is likely, drill hole at 10-degree angle or less and use prebent reinforcing bars.
4. If bars have fused epoxy coating and coating is damaged, recoat damaged area with epoxy.

E. Adhesive:

1. Install in accordance with 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 CONTROL

A. Special Inspection:

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 on Drawings and where concrete dowels are installed in overhead applications.
3. Periodic inspection required where continuous inspection is not specified.

END OF SECTION

SECTION 05 05 23
WELDING

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):
   a. BPVC SEC V, Nondestructive Examination.
   b. BPVC SEC IX, Welding and Brazing Qualifications.
2. American Society of Nondestructive Testing (ASNT): SNT-TC-1A, Personnel Qualification and Certification in Nondestructive Testing.
3. ASTM International (ASTM): A370, Standard Test Methods and Definitions for Mechanical Testing of Steel Products.
4. American Welding Society (AWS):
   a. A2.4, Standard Symbols for Welding, Brazing, and Nondestructive Examination.
   b. A3.0, Standard Welding Terms and Definitions.
   c. D1.1/D1.1M, Structural Welding Code - Steel.
   d. D1.2/D1.2M, Structural Welding Code - Aluminum.
   e. D1.3/1.3M, Structural Welding Code - Sheet Steel.
   f. D1.4/D1.4M, Structural Welding Code - Reinforcing Steel.
   g. D1.6/D1.6M, Structural Welding Code - Stainless Steel.
   h. QC1, Standard for AWS Certification of Welding Inspectors.

1.02 DEFINITIONS

A. CJP: Complete Joint Penetration.

B. CWI: Certified Welding Inspector.

C. MT: Magnetic Particle Testing.

D. NDE: Nondestructive Examination.

E. NDT: Nondestructive Testing.

F. PJP: Partial Joint Penetration.

G. PQR: Procedure Qualification Record.

H. PT: Liquid Penetrant Testing.

I. RT: Radiographic Testing.

J. UT: Ultrasonic Testing.

K. VT: Visual Testing.

L. WPQ: Welder/Welding Operator Performance Qualification.

M. WPS: Welding Procedure Specification.

1.03 SUBMITTALS

A. Shop Drawings:

1. Shop and field WPSs and PQRs.
2. NDT procedure specifications prepared in accordance with ASME BPVC SEC V.
3. Welding Data (Shop and Field): Submit welding data together with Shop Drawings as a complete package.
    a. Show on Shop Drawings or a weld map complete information regarding base metal specification designation, location, type, size, and extent of welds with reference called out for WPS and NDE numbers in tails of combined welding and NDE symbols as indicated in AWS A2.4.
    b. Distinguish between shop and field welds.
    c. Indicate, by welding symbols or sketches, details of welded joints and preparation of base metal. Provide complete joint welding details showing bevels, groove angles, and root openings for welds.
    d. For pipe fittings, provide a joint weld beveling diagram. Refer to AWS D1.1/D1.1M, Annex P Local Dihedral Angle that can be used to calculate bevels for weld joint details of intersecting pipes.
    e. Welding and NDE symbols shall be in accordance with AWS A2.4.
    f. Welding terms and definitions shall be in accordance with AWS A3.0.

B. Informational Submittals:

1. WPQs.
2. CWI credentials.
3. Testing agency personnel credentials.
4. CWI reports.
5. Welding Documentation: Submit on forms in referenced welding codes.

1.04 QUALIFICATIONS

A. WPSs: In accordance with AWS D1.1/D1.1M (Annex N Forms) for shop or field welding; or ASME BPVC SEC IX (Forms QW-482 and QW-483) for shop welding only.

B. WPQs: In accordance with AWS D1.1/D1.1M (Annex N Forms); or ASME BPVC SEC IX (Form QW-484).

C. CWI: Certified in accordance with AWS QC1, and having prior experience with specified welding codes. Alternate welding inspector qualifications require approval by Engineer.

D. Testing Agency: Personnel performing tests shall be NDT Level II certified in accordance with ASNT SNT-TC-1A.

1.05 SEQUENCING AND SCHEDULING

A. Unless otherwise specified, Submittals required in this section shall be submitted and approved prior to commencement of welding operations.

PART 2 PRODUCTS

2.01 SOURCE QUALITY CONTROL

A. CWI shall be present whenever shop welding is performed. CWI shall perform inspection, as necessary, prior to assembly, during assembly, during welding, and after welding. CWI shall perform inspections as required in AWS D1.1/D1.1M or referenced welding code and as follows:

1. Verifying conformance of specified job material and proper storage.
2. Monitoring conformance with approved WPS.
3. Monitoring conformance of WPQ.
4. Inspecting weld joint fit-up and performing in-process inspection.
5. Providing 100 percent visual inspection of welds.
6. Supervising nondestructive testing personnel and evaluating test results.
7. Maintaining records and preparing report confirming results of inspection and testing comply with the Work.

PART 3 EXECUTION

3.01 GENERAL

A. Welding and Fabrication by Welding: Conform to governing welding codes referenced in attached Welding and Nondestructive Testing Table.

3.02 NONDESTRUCTIVE WELD TESTING REQUIREMENTS

A. Weld Inspection Criteria:

1. Selection of welds to be tested, unless 100 percent NDT is specified herein, shall be as agreed upon between Engineer and Contractor.
2. Unless otherwise specified, perform NDT of welds at a frequency as shown below and in the attached Table in accordance with referenced welding codes as follows. Perform UT on CJP groove welds that cannot be readily radiographed. In case there is a conflict, higher frequency level of NDT shall apply.
   a. CJP Groove, Butt Joint Welds: 10 percent random RT.
   b. All other CJP Groove Welds: 10 percent random UT.
   c. Fillet Welds and PJP Groove Welds: 10 percent random PT or MT.
   d. All Welds: 100 percent VT.
3. Weld Acceptance:
   a. VT:
      1) Structural Pipe and Tubing: AWS D1.1/D1.1M, Paragraph 6.9, Visual Inspection, Tubular Connections.
      2) All Other Structural Steel: AWS D1.1/D1.1M, Paragraph 6.9, Visual Inspection, Statically Loaded Nontubular Connections.
      3) Stud Connections: AWS D1.1/D1.1M, Paragraph 7.8.1.
   b. UT: Perform on CJP groove welds in accordance with AWS D1.1/D1.1M, Paragraph 6.13.3, Class R Indications.
   c. RT: Perform on CJP butt joint welds in accordance with AWS D1.1/D1.1M, Paragraph 6.12.1.
   d. PT or MT:
      1) Perform on fillet and PJP groove welds in accordance with AWS D1.1/D1.1M, Paragraph 6.10.
      2) Acceptance shall be in accordance with VT standards specified above.

3.03 FIELD QUALITY CONTROL

A. CWI shall be present whenever field welding is performed. CWI shall perform inspection, as necessary, prior to assembly, during assembly, during welding, and after welding. CWI shall perform inspections as required in AWS D1.1/D1.1M or referenced welding code and as follows:

1. Verify conformance of specified job material and proper storage.
2. Monitor conformance with approved WPS.
3. Monitor conformance of WPQ.

4. Inspect weld joint fit-up and perform in-process inspection.
5. Provide 100 percent visual inspection of all welds.
6. Supervise nondestructive testing personnel and evaluating test results.
7. Maintain records and prepare report confirming results of inspection and testing comply with the Work.

3.04 WELD DEFECT REPAIR

A. Repair and retest rejectable weld defects until sound weld metal has been deposited in accordance with appropriate welding codes.

3.05 SUPPLEMENTS

A. The supplement listed below, following “End of Section,” is a part of this Specification.

1. Welding and Nondestructive Testing Table.

END OF SECTION

Welding and Nondestructive Testing						
Specification Section	**Governing Welding Codes or Standards**	**Submit WPS**	**Submit WPQ**	**Onsite CWI Req'd**	**Submit Written NDT Procedure Specifications**	**NDT Requirements**
05 50 00 Metal Fabrications	AWS D1.1/D1.1M, Structural Welding Code–Steel or AWS D1.2/D1.2M, Structural Welding Code - Aluminum or AWS D1.6/D1.6M, Structural Welding Code - Stainless Steel	**Yes**	**Yes**	Yes	**Yes**	100% VT; also see Section 05 50 00

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 Society of Safety Engineers (ASSE): A10.11, Safety Requirements for Personnel and Debris Nets.
7. 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.
8. ASTM International (ASTM):
   a. A36/A36M, Standard Specification for Carbon Structural Steel.
   b. A48/A48M, Specification for Gray Iron Castings.
   c. A53/A53M, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
   d. A108, Standard Specification for Steel Bar, Carbon and Alloy, Cold-Finished.
   e. A123/A123M, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
   f. A143/A143M, Standard for Safeguarding Against Embrittlement of Hot-Dip Galvanized Structural Steel Products and Procedure for Detecting Embrittlement.
   g. A153/A153M, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
   h. A193/A193M, Standard Specification for Alloy-Steel and Stainless Steel Bolting for High Temperature or High Pressure Service and Other Special Purpose Applications.
   i. A194/A194M, Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both.

j. A240/A240M, Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
k. A276, Standard Specification for Stainless Steel Bars and Shapes.
l. A283/A283M, Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates.
m. A307, Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.
n. A325, Standard Specification for Structural Bolts, Steel, Heat Treated 120/105 ksi Minimum Tensile Strength.
o. A380, Standard Practice for Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment, and Systems.
p. A384/A384M, Standard Practice for Safeguarding Against Warpage and Distortion During Hot-Dip Galvanizing of Steel Assemblies.
q. A385/A385M, Standard Practice for Providing High-Quality Zinc Coatings (Hot-Dip).
r. A489, Standard Specification for Carbon Steel Lifting Eyes.
s. A500/A500M, Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.
t. A501, Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing.
u. A563, Standard Specification for Carbon and Alloy Steel Nuts.
v. A653/A653M, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
w. A780/A780, Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings.
x. A786/A786M, Standard Specification for Hot-Rolled Carbon, Low-Alloy, High-Strength Low-Alloy, and Alloy Steel Floor Plates.
y. A793, Standard Specification for Rolled Floor Plate, Stainless Steel.
z. A967, Standard Specification for Chemical Passivation Treatments for Stainless Steel Parts.
aa. A992/A992M, Standard Specification for Structural Steel Shapes.
bb. B209, Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
cc. B308/B308M, Standard Specification for Aluminum-Alloy 6061-T6 Standard Structural Profiles.
dd. B429/B429M, Standard Specification for Aluminum-Alloy Extruded Structural Pipe and Tube.
ee. B632/B632M, Standard Specification for Aluminum-Alloy Rolled Tread Plate.

ff. C881/C881M, Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete.
gg. D1056, Standard Specification for Flexible Cellular Materials - Sponge or Expanded Rubber.
hh. F436, Standard Specification for Hardened Steel Washers.
ii. F468, Standard Specification for Nonferrous Bolts, Hex Cap Screws, and Studs for General Use.
jj. F593, Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.
kk. F594, Standard Specification for Stainless Steel Nuts.
ll. F844, Standard Specification for Washers, Steel, Plain (Flat), Unhardened for General Use.
mm. F1554, Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength.

9. International Code Council Evaluation Service (ICC-ES):
   a. AC01, Acceptance Criteria for Expansion Anchors in Masonry Elements.
   b. AC106, Acceptance Criteria for Predrilled Fasteners (Screw Anchors) in Masonry Elements.
   c. AC193, Acceptance Criteria for Mechanical Anchors in Concrete Elements.
   d. AC308, Acceptance Criteria for Post-Installed Adhesive Anchors in Concrete Elements.
   e. AC70, Acceptance Criteria for Fasteners Power-driven into Concrete, Steel and Masonry Elements.
10. NSF International (NSF): 61, Drinking Water System Components—Health Effects.
11. 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.
12. 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. Concrete Anchor: Post-installed concrete anchors listed in this Specification.

C. Corrosive Area: Containment area or area exposed to delivery, storage, transfer, or use of chemicals.

D. Exterior Area: Location not protected from weather by building or other enclosed structure.

E. 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:
   a. Metal fabrications, including welding and fastener information.
   b. Specific instructions for concrete anchor installation, including drilled hole size, preparation, placement, procedures, and instructions for safe handling of anchoring systems.

B. Informational Submittals:

1. Concrete and Post-Installed Anchors:
   a. Manufacturer’s product description and printed installation instructions.
   b. Current ICC-ES Report for each type of post-installed anchor to be used.
   c. Adhesive Anchor Installer Certification.

1.04 QUALITY ASSURANCE

A. Qualifications:

1. Adhesive Anchor Installer: Trained to install adhesive anchors in accordance with manufacturer’s printed installation instructions.
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. Insofar as practical, factory assemble specified items. Assemblies, because of necessity, have to be shipped unassembled shall be packaged and tagged in manner that will protect materials from damage and will facilitate identification and field assembly.

B. Package stainless steel items in a manner 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.

E. Store adhesives anchors at service temperature ranges recommended by manufacturer.

PART 2 PRODUCTS

2.01 GENERAL

A. Unless otherwise indicated, meet the following requirements:

Item	ASTM Reference
Steel Wide Flange Shapes	A992/A992M
Other Steel Shapes and Plates	A36/A36M
Steel Pipe	A501 or A53/A53M, Type E or S, Grade B
Stainless Steel:	
Bars and Angles	A276, AISI Type 316 (316L for welded connections)
Shapes	A276, AISI Type 316 (316L for welded connections)
Steel Plate, Sheet, and Strip	A240/A240M, AISI Type 316 (316L for welded connections)
Bolts, Threaded Rods, Anchor Bolts, and Anchor Studs	F593, AISI Type 316, Condition CW
Nuts	F594, AISI Type 316, Condition CW

B. Bolts, Washers, and Nuts: Use stainless steel.

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.

3. Fusion bonded coating, where required, shall be 100 percent solids, thermosetting, fusion bonded, dry powder epoxy, suitable for the intended service applied by electrostatic, fluidized bed, or flocking. Minimum cover shall be one or two coats with 7 mils dry film thickness. Surface preparation shall be SP10, Near-White Blast Cleaning.

2.03 POST-INSTALLED CONCRETE ANCHORS

A. General:

1. AISI Type 316 stainless.
2. Current ICC-ES Report indicating acceptance per IBC 2012.
3. Anchors shall be suitable for long-term loads, as well as for wind and seismic loads.
4. Torque-Controlled Expansion Anchors (Wedge Anchors):
   a. Wedge anchors used in sustained tension applications (such as overhead or cantilevered applications) shall have current ICC-ES Report that demonstrates compliance with ICC-ES AC193 for cracked concrete.
   b. Manufacturers and Products:
      1) Hilti, Inc., Tulsa, OK; Kwik-Bolt–TZ (KB-TZ) Anchors (ESR-1917).
      2) Powers Fasteners, Brewster, NY; Power-Stud +SD2 or +SD1 Anchors (ESR-2502 and ESR-2818).
      3) Simpson Strong-Tie Co., Inc., Pleasanton, CA; Strong-Bolt Anchors (ESR-1771).
5. Heavy-Duty Torque Controlled Expansion Anchors (Sleeve Anchors):
   a. Manufacturers and Products:
      1) Powers Fasteners, Brewster, NY; Power-Bolt+ Anchor.
      2) Hilti, Inc., Tulsa, OK; HSL-3 Heavy Duty Sleeve Anchor.

B. Adhesive Anchors (Epoxy Anchors):

1. If approved by Engineer, adhesive anchors used in sustained tension applications (such as overhead or cantilevered applications) shall have current ICC-ES Report that demonstrates compliance with ICC-ES AC308 for cracked concrete.
2. Threaded Rod:
   a. ASTM F593 stainless steel threaded rod, diameter as shown on Drawings.
   b. Length as required, to provide minimum depth of embedment.
   c. Clean and free of grease, oil, or other deleterious material.
3. 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.
c. Mixed Adhesive: Nonsag light paste consistency with ability to remain in 1-inch diameter overhead drilled hole without runout.
d. Meet requirements of ASTM C881/C881M.

4. Packaging and Storage:
a. Disposable, self-contained cartridge system capable of dispensing both components in proper mixing ratio and fitting into manually or pneumatically operated caulking gun.
b. Store adhesive cartridges and adhesive components on pallets or shelving in covered storage area.
c. Container Markings: Include manufacturer's name, product name, batch number, mix ratio by volume, product expiration date, ANSI hazard classification, and appropriate ANSI handling precautions.
d. Dispose of when:
1) Shelf life has expired.
2) Stored other than in accordance with manufacturer's instructions.

5. Manufacturers and Products:
a. Hilti, Inc., Tulsa, OK; HIT Doweling Anchor System, HIT RE 500 SD (ESR-2322).
b. Simpson Strong-Tie Co., Inc., Pleasanton, CA; SET-XP Epoxy Adhesive Anchors(ESR-2508).
c. Powers Fasteners, Brewster NY, PE1000+ Adhesive anchoring system (ESR-2583).

C. Adhesive Threaded Inserts:

1. Stainless steel, internally threaded inserts.
2. Manufacturer and Product: Hilti, Inc., Tulsa, OK; HIS-RN Insert with HIT-RE 500-SD adhesive.

2.04 PIPE SLEEVES

A. AISI Type 316L Schedule 40 stainless steel pipe sleeves with continuously welded 3/16-inch-thick seep ring with outside diameter 3 inches greater than sleeve outside diameter.

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: Use stainless steel shapes, unless otherwise noted.

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. Stainless Steel: Meet requirements of AWS D1.6/D1.6M.
5. 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.
6. Complete welding before applying finish.

D. Fitting: Where movement of fabrications is required or shown, cut, fit, and align items for smooth operation. Make corners square and opposite sides parallel.

E. 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. 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. Pipe Sleeves:

1. Provide where pipes pass through concrete.
2. Provide center flange for water stoppage on sleeves in exterior or water-bearing walls.
3. Provide rubber caulking sealant or a modular mechanical unit to form watertight seal in annular space between pipes and sleeves.

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 CONCRETE AND POST-INSTALLED ANCHORS

A. Begin installation only after concrete or masonry to receive anchors has attained design strength.

B. Install in accordance with manufacturer's instructions.

C. Provide minimum embedment, edge distance, and spacing as follows, unless indicated otherwise by anchor manufacturer's instructions or shown otherwise on Drawings:

Anchor Type	Minimum Embedment (Bolt Diameters)	Minimum Edge Distance (Bolt Diameters)	Minimum Spacing (Bolt Diameters)
Expansion	9	6	12
Adhesive	9	9	13.5

D. Use only drill type and bit type and diameter recommended by anchor manufacturer. Clean hole of debris and dust with brush and compressed air per manufacturer's printed installation instructions.

E. When embedded steel or rebar is encountered in drill path, slant drill to clear obstruction. If drill must be slanted more than 6 degrees to clear obstruction, notify Engineer for direction on how to proceed.

F. Adhesive Anchors:

1. Do not install adhesive anchors when temperature of concrete is below 40 degrees F or above 100 degrees F, unless cold temperature adhesives, compliant with ACI 308 are used. Refer to the respective ICC-ES report and manufacturer's printed installation instructions.
2. Remove water from hole with oil-free compressed air. Damp or water filled holes may be allowed only if approved in manufacturer's printed installation instructions and ICC-ES report.
3. For hollow-unit masonry, install screen tube in accordance with manufacturer's printed installation instructions.
4. Do not disturb anchor during recommended curing time.
5. Do not exceed maximum torque as specified in manufacturer's printed installation instructions.

3.04 ELECTROLYTIC PROTECTION

A. 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.

3.05 FIELD QUALITY CONTROL

A. Owner-Furnished Quality Assurance:

1. In accordance with IBC Chapter 17 requirements, is provided in the Statement of Special Inspections Plan on Drawings.
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. Concrete Drilled Anchors: Special inspection and testing will be provided by Owner where indicated on Drawings.

3.06 MANUFACTURER'S SERVICES

A. Anchor Installation: Conduct Site training of installation personnel for proper installation, handling, and storage of mechanical and adhesive anchor systems. Notify Engineer of time and place for sessions.

3.07 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		
Exterior and Interior Wet Areas	Stainless steel headed anchor bolts	
Submerged and Corrosive Areas	Stainless steel headed anchor bolts with fusion bonded coating	
2. Anchor Bolts Cast Into Concrete for Equipment Bases		
Submerged, Exterior, Interior Wet, and Corrosive Areas	Stainless steel headed anchor bolts with fusion bonded coating, unless otherwise specified with equipment	
3. Drilled Anchors for Metal Components to Cast-in-Place Concrete (such as, Ladders, Handrail Posts, Electrical Panels, and Equipment)		
Submerged, Exterior, Interior Wet, and Corrosive Areas	Adhesive stainless steel anchors	
4. All Others		
Exterior and Interior Wet and Dry Areas	Stainless steel fasteners	

B. Antiseizing Lubricant: Use on 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 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. International Code Council (ICC): International Building Code (IBC).
3. Occupational Safety and Health Act (OSHA): 29 CFR 19.10, Code of Federal Regulations.
4. 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 ladders, 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.
      5) Ladders and ladder 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.

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. Pultruded Type:

1. Main bars joined by cross bars secured in holes drilled in main bars.
2. Cross bars with 6-inch maximum spacing shall mechanically lock main bars in position such that they prevent movement.
3. Intersections: Bond using adhesive as corrosive-resistant as pultrusion resin.
4. Main Bar Ends: Minimum bearing support width of 1-1/2 inches.
5. Skid-Resistant Surface: Grit adhesively bonded, manufacturer’s standard.
6. Provide extra stiffness around openings.

D. Hold-Down Clamps: Type 316 stainless steel.

E. Bolts and Connectors:

1. Corrosion-resistant FRP or Type 316 stainless steel.
2. Size and strength to meet IBC requirements.

F. 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.

G. 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 DESIGN REQUIREMENTS

A. Structural Performance of Railing Systems: Design, test, fabricate, and install railings to withstand the following structural loads without exceeding allowable design working stress or allowable deflection. Apply each load to produce maximum stress and deflection in railing system components.

1. Railing System: Capable of withstanding the following load cases applied:
   a. Concentrated load of 200 pounds applied at any point and in any direction in accordance with ICC IBC and OSHA.
   b. Uniform load of 50 pounds per linear foot applied in any direction in accordance with ICC IBC.
   c. Concentrated load need not be assumed to act concurrently with uniform loads in accordance with ICC IBC.
2. Calculated lateral deflection at top of posts shall not exceed 1 inch.

B. Thermal Movement:

1. Allow for maximum range of ambient temperature change (difference between high or low and installation temperature).
2. Base design on actual surface temperatures of materials due to both solar heat gain and night time sky heat loss.
3. Temperature Change Range: 70 degrees F, ambient; 100 degrees F, material surfaces.

C. Rails and Posts:

1. 2-inch nominal square or round tubing posts.
2. 1-3/4- or 2-inch nominal round or square rails.
3. Maximum Post Spacing: 5 feet.

D. Kickplates: Corrugated, 4 inches by 1/2 inch by 0.125 inch thick or 4 inches by 9/16 inch thick at handrail locations.

E. Kickplate Connectors and Splices: Continuous with provision for expansion and contraction without distortion or buckling.

F. Connections, Mounts, Bases: Fiberglass or Type 316 stainless steel.

G. Pultruded Parts:

Minimum Mechanical Properties	**Test Method**	**Values**
Tensile Stress	ASTM D638	30,000 psi
Tensile Modulus	ASTM D638	2.5×10^6 psi
Compressive Stress	ASTM D695	30,000 psi
Compressive Modulus	ASTM D695	2.5×10^6 psi
Flexural Stress	ASTM D790	30,000 psi
Flexural Modulus	ASTM D790	1.6×10^6 psi
Shear Stress	ASTM D2344	4,500 psi
Density	ASTM D792	0.060-0.070 lbs/in.^{3}
24-Hour Water Absorption	ASTM D570	0.6% max.
Coefficient of Thermal Expansion	ASTM D696	4.4×10^{-6} in./in./degree F
Flexural Stress	Full Section	36,000 psi
Flexural Modulus	Full Section	3.7×10^6 psi

H. Manufacturers:

1. Strongwell Corp., Bristol, VA.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. 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 LADDERS

A. Epoxy and rivet joints and rungs.

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): RP0188, Discontinuity (Holiday) Testing of New Protective Coatings on Conductive Substrates.
4. NSF International (NSF):
   a. NSF/ANSI 61, Drinking Water System Components - Health Effects.
   b. NSF/ANSI 372, Drinking Water System Components - Lead Content.
5. Occupational Safety and Health Act (OSHA).
6. The Society for Protective Coatings (SSPC):
   a. PA 2, Measurement of Dry Coating Thickness with Magnetic Gages.
   b. PA 3, Guide to Safety in Paint Applications.
   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 12, Surface Preparation and Cleaning of Metals Waterjetting Prior to Recoating.
   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. HCl: Hydrochloric Acid.
4. MDFT: Minimum Dry Film Thickness, mils.
5. MDFTPC: Minimum Dry Film Thickness per Coat, mils.
6. Mil: Thousandth of an inch.
7. PDS: Product Data Sheet.
8. PSDS: Paint System Data Sheet.
9. PVC: Polyvinyl Chloride.
10. SFPG: Square Feet per Gallon.
11. SFPGPC: Square Feet per Gallon per Coat.
12. 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.
2. Samples:
   a. Proposed Abrasive Materials: Minimum 5-pound sample for each type.

b. Reference Panel:
   1) Surface Preparation:
      a) Prior to start of surface preparation, furnish a 4-inch by 4-inch steel panel for each grade of sandblast specified herein, prepared to specified requirements.
      b) Provide panel representative of the steel used; prevent deterioration of surface quality.
      c) Panel to be reference source for inspection upon approval by Engineer.
   2) Paint:
      a) Unless otherwise specified, before painting work is started, prepare minimum 8-inch by 10-inch sample with type of paint and application specified on similar substrate to which paint is to be applied.
      b) Furnish additional samples as required until colors, finishes, and textures are approved.
      c) Approved samples to be the quality standard for final finishes.

B. Informational Submittals:

1. Applicator's Qualification: List of references substantiating experience.
2. Coating Manufacturer's Certificate of Compliance, in accordance with Section 01 61 00, Common Product Requirements.
3. Factory Applied Coatings: Manufacturer's certification stating factory applied coating system meets or exceeds requirements specified.
4. Manufacturer's written verification that submitted material is suitable for the intended use.
5. If the manufacturer of finish coating differs from that of shop primer, provide finish coating manufacturer's written confirmation that materials are compatible.
6. Manufacturer's written instructions and special details for applying each type of paint.

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 3, Guide to Safety in Paint Applications.
   c. Federal, state, and local agencies having jurisdiction.

C. Mockup:

1. Before proceeding with Work under this section, finish one complete space or item of each color scheme required showing selected colors, finish texture, materials, quality of work, and special details.
2. After Engineer approval, sample spaces or items shall serve as a standard for similar work throughout the Project.

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.

B. Status of Existing Coatings: Perform tests as required to verify the condition of existing coatings or substrates to be –recoated.

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. 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.

2.03 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.

2.04 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
Alkyd (Semigloss)	Semigloss alkyd
Alkyd Enamel	Optimum quality, gloss or semigloss finish as required, medium long oil
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
DTM Acrylic Primer	Surface tolerant, direct-to-metal water borne acrylic primer
DTM Acrylic Finish	Surface tolerant, direct-to-metal water borne acrylic finish coat
Elastomeric Polyurethane	100% solids, plural component, spray applied, high build, elastomeric polyurethane coating, suitable for the intended service
Epoxy Filler/Surfacer	100% solids epoxy trowel grade filler and surfacer, nonshrinking, suitable for application to concrete and masonry. Approved for potable water contact and conforming to NSF/ANSI 61, where required
Epoxy Primer—Ferrous Metal	Anticorrosive, converted epoxy primer containing rust-inhibitive pigments
Epoxy Primer—Other	Epoxy primer, high-build, as recommended by coating manufacturer for specific galvanized metal, copper, or nonferrous metal alloy to be coated
Fusion Bonded Coating	100% solids, thermosetting, fusion bonded, dry powder epoxy, suitable for the intended service
Fusion Bonded, TFE Lube or Grease Lube	Tetrafluoroethylene, liquid coating, or open gear grease as supplied by McMaster-Carr Supply Corporation., Elmhurst, IL; RL 736 manufactured by Amrep, Inc., Marietta, GA
High Build Epoxy	Polyamidoamine epoxy, minimum 69% volume solids, capability of 4 to 8 MDFT per coat
Inorganic Zinc Primer	Solvent or water based, having 85% metallic zinc content in the dry film; follow manufacturer's recommendation for topcoating

Product	Definition
NSF Epoxy	Polyamidoamine epoxy, approved for potable water contact and conforming to NSF/ANSI 61
Epoxy, High Solids	Polyamidoamine epoxy, 80% volume solids, minimum, suitable for immersion service
Polyurethane Enamel	Two-component, aliphatic or acrylic based polyurethane; high gloss finish
Rust-Inhibitive Primer	Single-package steel primers with anticorrosive pigment loading
Silicone/Silicone Acrylic	Elevated temperature silicone or silicone/acrylic based
Water Base Epoxy	Two-component, polyamide epoxy emulsion, finish as required

2.05 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.

2.06 SHOP FINISHES

A. Shop Blast Cleaning: Reference Paragraph, Shop Coating Requirements.

B. Surface Preparation: Provide Engineer minimum 7 days' advance notice to start of shop surface preparation work and coating application work.

C. 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.

D. Pipe:

1. Ductile Iron Pipe:
   a. Use SSPC standards as a guide for desired prepared surface. Follow recommendations of pipe and coating manufacturers for means and methods to achieve SSPC-equivalent surface.
   b. The surface preparation and application of the primer and finish coats shall be performed by pipe manufacturer.
   c. For high performance (epoxy) coatings, follow additional recommendations of pipe and coating manufacturers.
   d. Prior to blast cleaning, grind smooth surface imperfections, including, but not limited to delaminating metal or oxide layers.
   e. For conventional (alkyd) coatings, clean asphalt varnish supplied on pipe and apply one full coat of a tar stop before two full coats of the color coats specified.

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. Surface Contamination Testing:

1. A surface contamination analysis test shall be performed every 500 square feet by means of a Chlor Test CSN Salts or approved equivalent.
2. Surface with chloride levels exceeding 3 µg/square centimeter for submerged surfaces and 5 µg/square centimeter for exposed surfaces shall be treated with a liquid soluble salt remover equivalent to CHLOR*RID (CHLOR*RID International, Chandler, AZ).
3. Follow manufacturer’s recommendations and procedures for the use of this product to remove the surface contamination.

C. 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.
   d. SP 5, White Metal Blast Cleaning: Removal of visible oil, grease, dust, dirt, mill scale, rust, coatings, oxides, corrosion products, and other foreign matter by blast cleaning.
   e. SP 6, Commercial Blast Cleaning: Removal of visible oil, grease, dust, dirt, mill scale, rust, coatings, oxides, corrosion products, and other foreign matter, except for random staining limited to no more than 33 percent of each unit area of surface which may consist of light shadows, slight streaks, or minor discolorations caused by stains of rust, stains of mill scale, or stains of previously applied coatings.
   f. SP 7, Brush-Off Blast Cleaning: Removal of visible rust, oil, grease, soil, dust, loose mill scale, loose rust, and loose coatings. Tightly adherent mill scale, rust, and coating may remain on surface.
   g. SP 10, Near-White Blast Cleaning: Removal of visible oil, grease, dust, dirt, mill scale, rust, coatings, oxides, corrosion products, and other foreign matter, except for random staining limited to no more than 5 percent of each unit area of surface which may consist of light shadows, slight streaks, or minor discolorations caused by stains of rust, stains of mill scale, or stains of previously applied coatings.
   h. SP 11, Power Tool Cleaning to Bare Metal: Removal of visible oil, grease, dirt, dust, mill scale, rust, paint, oxide, corrosion products, and other foreign matter using power-assisted hand tools capable of producing suitable surface profile. Slight residues of rust and paint may be left in lower portion of pits if original surface is pitted.
   i. SP 12, Surface Preparation and Cleaning of Metals by Waterjetting Prior to Recoating: Surface preparation using high-pressure and ultrahigh-pressure water jetting to achieve specified surface cleanliness condition. Surface cleanliness conditions are defined in SSPC SP 12 and are designated WJ-1 through WJ-4 for visual surface preparation definitions and SC-1 through SC-3 for nonvisual surface preparation definitions.

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. Ductile Iron Pipe Supplied with Asphaltic Varnish Finish: Remove asphaltic varnish finish prior to performing specified surface preparation.
5. Hand tool clean areas that cannot be cleaned by power tool cleaning.
6. Round or chamfer sharp edges and grind smooth burrs, jagged edges, and surface defects.
7. Welds and Adjacent Areas:
    a. Prepare such that there is:
        1) No undercutting or reverse ridges on weld bead.
        2) No weld spatter on or adjacent to weld or any area to be painted.
        3) No sharp peaks or ridges along weld bead.
    b. Grind embedded pieces of electrode or wire flush with adjacent surface of weld bead.
8. 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.
9. 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.

10. 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.

D. Galvanized Metal, Copper, and Nonferrous Metal Alloy Surface Preparation:

1. Remove soil, cement spatter, and other surface dirt with appropriate hand or power tools.
2. Remove oil and grease by wiping or scrubbing surface with suitable solvent, rag, and brush. Use clean solvent and clean rag for final wiping to avoid contaminating surface.
3. Obtain and follow coating manufacturer's recommendations for additional preparation that may be required.

E. 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.

F. Plastic and FRP Surface Preparation:

1. Hand sand plastic surfaces to be coated with medium grit sandpaper to provide tooth for coating system.
2. Large areas may be power sanded or brush-off blasted, provided sufficient controls are employed so surface is roughened without removing excess material.

G. Masonry Surface Preparation:

1. Complete and cure masonry construction for 14 days or more before starting surface preparation work.
2. Remove oil, grease, dirt, salts or other chemicals, loose materials, or other foreign matter by solvent, detergent washing, or other suitable cleaning methods.
3. Clean masonry surfaces of mortar and grout spillage and other surface deposits using one of the following:
    a. Nonmetallic fiber brushes and commercial muriatic acid followed by rinsing with clean water.
    b. Brush-off blasting.
    c. Water blasting.
4. Do not damage masonry mortar joints or adjacent surfaces.
5. Leave surfaces clean and, unless otherwise required for proper adhesion, dry prior to painting.
6. Masonry Surfaces to be Painted: Uniform texture and free of surface imperfections that would impair intended finished appearance.
7. Masonry Surfaces to be Clear Coated: Free of discolorations and uniform in texture after cleaning.

H. 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. For ductile iron pipe with asphaltic varnish finish not specified to be abrasive blasted, apply coat of tar stop prior to application of cosmetic finish coat.
8. 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.
9. Perform blasting as required to restore damaged surfaces. Materials, equipment, procedures shall meet requirements of SSPC.

3.05 SURFACE CLEANING

A. Brush-off Blast Cleaning:

1. Equipment, procedure, and degree of cleaning shall meet requirements of SSPC SP 7.
2. Abrasive: Either wet or dry blasting sand, grit, or nutshell.
3. Select various surface preparation parameters, such as size and hardness of abrasive, nozzle size, air pressure, and nozzle distance from surface such that surface is cleaned without pitting, chipping, or other damage.
4. Verify parameter selection by blast cleaning a trial area that will not be exposed to view.
5. Engineer will review acceptable trial blast cleaned area and use area as a representative sample of surface preparation.
6. Repair or replace surface damaged by blast cleaning.

B. Acid Etching:

1. After precleaning, spread the following solution by brush or plastic sprinkling can: One part commercial muriatic acid reduced by two parts water by volume. Adding acid to water in these proportions gives an approximate 10 percent solution of HCl.
2. Application:
   a. Rate: Approximately 2 gallons per 100 square feet.
   b. Work acid solution into surface by hard-bristled brushes or brooms until complete wetting and coverage is obtained.
   c. Acid will react vigorously for a few minutes, during which time brushing shall be continued.
   d. After bubbling subsides (10 minutes), hose down remaining slurry with high pressure clean water.
   e. Rinse immediately to avoid formation on the surface of salts that are difficult to remove.
   f. Thoroughly rinse to remove any residual acid surface condition that may impair adhesion.
3. Ensure surface is completely dry before application of coating.
4. Apply acid etching to obtain a “grit sandpaper” surface profile. If not, repeat treatment.

C. 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 metal, and submerged metal surfaces to be painted, whether specifically mentioned or not, except as specified otherwise. Do not paint exterior concrete surfaces, unless specifically indicated.
2. Extent of Coating (Immersion): Coatings shall be applied to internal vessel and pipe surfaces, nozzle bores, flange gasket sealing surfaces, carbon steel internals, and stainless steel internals, unless otherwise specified.
3. For coatings subject to immersion, obtain full cure for completed system. Consult coatings manufacturer's written instructions for these requirements. Do not immerse coating until completion of curing cycle.
4. Apply coatings in accordance with these Specifications and paint manufacturers' printed recommendations and special details. The more stringent requirements shall apply. Allow sufficient time between coats to assure thorough drying of previously applied paint.
5. Vacuum clean surfaces free of loose particles. Use tack cloth just prior to applying next coat.
6. Fusion Bonded Coatings Method Application: Electrostatic, fluidized bed, or flocking.
7. Coat units or surfaces to be bolted together or joined closely to structures or to one another prior to assembly or installation.
8. On pipelines, terminate coatings along pipe runs to 1 inch inside pipe penetrations.
9. Keep paint materials sealed when not in use.
10. 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. Galvanized Metal, Copper, and Nonferrous Metal Alloys:

1. Concealed galvanized, copper, and nonferrous metal alloy surfaces (behind building panels or walls) do not require painting, unless specifically indicated herein.
2. Prepare surface and apply primer in accordance with System No. 10 specification.
3. Apply intermediate and finish coats of the coating system appropriate for the exposure.

C. Porous Surfaces, Such As Concrete and Masonry:

1. Filler/Surfacer: Use coating manufacturer's recommended product to fill air holes, bug holes, and other surface voids or defects.

2. Prime Coat: May be thinned to provide maximum penetration and adhesion.
   a. Type and Amount of Thinning: Determined by paint manufacturer and dependent on surface density and type of coating.
3. Surface Specified to Receive Water Base Coating: Damp, but free of running water, just prior to application of coating.

D. 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. Piping to be painted with system indicated on Piping Schedule (Section 40 27 00, Process Piping-General).

C. System No. 1 Submerged Metal—Potable Water:

Surface Prep.	Paint Material	Min. Coats, Cover
SP 5, White Metal Blast Cleaning	NSF Epoxy	3 coats, 3 MDFTPC

1. Use on the following items or areas:
   a. Metal surfaces new and existing below a plane 1 foot above the maximum liquid surface; metal surfaces above the maximum liquid surface that are a part of the immersed equipment; surfaces of metallic items, such as wall pipes, pipes, pipe sleeves, access manholes, gate guides and thimbles, and structural steel that are embedded in concrete; and the following specific surfaces:
      1) Interior surfaces of steel piping noted in the Piping Schedule.

D. System No. 1A Concrete Saw Cut Repair Coating:

Surface Prep.	Paint Material	Min. Coats, Cover
Brush blast concrete in accordance with Paragraph Concrete Surface Preparation; blast exposed reinforcing steel to Near White Metal, SSPC SP10. See Note 1	High Build Epoxy, finish color gray	2 coats, 6 to 8 mils dry film thickness per coat, see Note 2.
Note 1. Surface preparation alternative: Mechanical abrade concrete surfaces to meet International Concrete Restoration Association standard 37/32, Concrete Surface Profile No. 3. Mechanically abrade exposed ends of reinforcing steel in accordance with SSPC SP-11. Note 2. Brush out all surface voids and irregularities to provide a monolithic film.		

1. Use on the following items or areas:
   a. All exposed surfaces of saw-cut concrete.

E. 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, located inside or outside of structures and exposed to weather, and the following specific surfaces:
      1) Exposed structural steel framing and columns, and interior exposed metal roof deck.

F. System No. 5 Exposed Metal—Mildly Corrosive:

Surface Prep.	Paint Material	Min. Coats, Cover
SP 10, Near-White Blast Cleaning	Epoxy Primer—Ferrous Metal	1 coat, 2.5 MDFT
	Polyurethane Enamel	1 coat, 3 MDFT

1. Use on the following items or areas:
   a. Exposed metal surfaces, located inside or outside of structures and exposed to weather or in a highly humid atmosphere, such as pipe galleries and similar areas.

G. 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 metal surfaces, located inside or outside of structures or exposed to weather, including 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.

H. 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
	High Build Epoxy	

1. Use on the following items or areas:
   a. Use on concrete encased ferrous metals including wall pipes, pipe sleeves, access manholes, gate guides, and thimbles.

I. System No. 8 Buried Metal—General:

Surface Prep.	Paint Material	Min. Coats, Cover
SP 10, Near-White Blast Cleaning	Standard Hot Coal-Tar Enamel -OR- Coal-Tar Epoxy	AWWA C203 2 coats, 16 MDFT
	For Highly Abrasive Soil, Brackish Water: Tape Coat System	AWWA C214 with Double Outer Wrap

1. For steel pipe and fittings, follow AWWA C209 and AWWA C214 with double outer wrap.
2. Use on the following items or areas:
   a. Buried, belowgrade portions of steel items, except buried stainless steel or ductile iron.

J. System No. 10 Galvanized Metal, Copper, and Nonferrous Metal Alloy Conditioning:

Surface Prep.	Paint Material	Min. Coats, Cover
In accordance with Paragraph Galvanized Metal, Copper, and Nonferrous Metal Alloy Surface Preparation	Epoxy Primer—Other	As recommended by coating manufacturer Remaining coats as required for exposure

1. Use on the following items or areas:
   a. Galvanized surfaces requiring painting.
   b. After application of System No. 10, apply finish coats as required for exposure.

K. System No. 25 Exposed FRP, PVC:

Surface Prep.	Paint Material	Min. Coats, Cover
In accordance with Paragraph Plastic and FRP Surface Preparation	Acrylic Latex Semigloss	2 coats, 320 SFPGPC

1. Use on the following items or areas:
   a. All exposed-to-view PVC and CPVC surfaces, and FRP surfaces without integral UV-resistant gel coat.

L. 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.

M. System No. 29 Fusion Bonded Coating:

Surface Prep.	Paint Material	Min. Coats, Cover
SP 10, Near-White Blast Cleaning	Fusion Bonded Coating 100% Solids Epoxy	1 or 2 coats, 7 MDFT

1. For steel pipe and fittings, meet all requirements of AWWA C213.

N. System No. 29A Fusion Bonded, Steel Dowel Coating:

Surface Prep.	Paint Material	Min. Coats, Cover
SP 10, Near-White Blast Cleaning	Fusion Bonded Coating 100% Solids Epoxy	1 or 2 coats, 7 MDFT
TFE Lube, Shop Applied; Grease Lube Alternative, Field Applied Just Prior to Installation	TFE Lube or Grease Lube	1 coat, as required

1. Use on steel expansion joint dowels as specified in Section 03 15 00, Concrete Joints and Accessories.

3.08 ARCHITECTURAL PAINT 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. 108 Masonry, Flat:

Surface Prep.	**Paint Material**	**Min. Coats, Cover**
In accordance with Paragraph Masonry Surface Preparation	Block Filler	1 coat, 75 SFPG
	Acrylic Latex (Flat)	2 coats, 240 SFPGPC

1. Use on the following items or areas:
   a. Chemical Building.

C. System No. 109 Masonry, Semigloss:

Surface Prep.	**Paint Material**	**Min. Coats, Cover**
In accordance with Paragraph Masonry Surface Preparation	Block Filler	1 coat, 75 SFPG
	Acrylic Latex (Semigloss)	2 coats, 240 SFPGPC

1. Use on the following items or areas:
   a. Chemical Building.

D. System No. 110 Masonry Sealer:

Surface Prep.	**Paint Material**	**Min. Coats, Cover**
In accordance with Paragraph Masonry Surface Preparation	Acrylic Sealer	2 coats, 100 SFPGPC

1. Use on the following items or areas:
   a. Chemical Building.

E. System No. 111 Concrete and Masonry, Stain and Seal:

Surface Prep.	Paint Material	Min. Coats, Cover
Concrete: In accordance with Paragraph Concrete Surface Preparation -OR- Masonry: In accordance with Paragraph Masonry Surface Preparation	Stain, Concrete	2 coats, 250 SFPGPC
	Acrylic Sealer	2 coats, 100 SFPGPC

1. Use on the following items or areas:
   a. Chemical Building.

F. System No. 112 Concrete, Flat:

Surface Prep.	Paint Material	Min. Coats, Cover
In accordance with Paragraph Concrete Surface Preparation	Acrylic Latex (Flat)	2 coats, 240 SFPGPC

1. Use on the following items or areas:
   a. Chemical Building.

G. System No. 113 Concrete, Semigloss:

Surface Prep.	Paint Material	Min. Coats, Cover
In accordance with Paragraph Concrete Surface Preparation	Acrylic Latex (Semigloss)	2 coats, 240 SFPGPC

1. Use on the following items or areas:
   a. Chemical Building.

3.09 COLORS

A. Provide as shown in Piping Schedule.

B. Proprietary identification of colors is for identification only. Selected manufacturer may supply matches.

C. Equipment Colors:

1. Equipment includes the machinery or vessel itself plus the structural supports and fasteners and attached electrical conduits.

2. Paint equipment and piping one color as selected.
3. Paint nonsubmerged portions of equipment the same color as the piping it serves, except as itemized below:
    a. Dangerous Parts of Equipment and Machinery: OSHA Orange.
    b. Fire Protection Equipment and Apparatus: OSHA Red.
    c. Radiation Hazards: OSHA Purple.
    d. Physical hazards in normal operating area and energy lockout devices, including, but not limited to, electrical disconnects for equipment and equipment isolation valves in air and liquid lines under pressure: OSHA Yellow.

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. On exposed stainless steel piping, apply color 24 inches in length along pipe axis at connections to equipment, valves, or branch fittings, at wall boundaries, and at intervals along piping not greater than 9 feet on center.
4. Pipe Supports: Painted light gray, as approved by Owner.

3.10 PIPE FIELD QUALITY CONTROL

A. Testing Equipment:

1. Provide magnetic type dry film thickness gauge to test coating thickness specified in mils, as manufactured by Nordson Corp., Anaheim, CA, Mikrotest.
2. Provide low-voltage wet sponge electrical holiday detector to test completed coating systems, 20 mils dry film thickness or less, except zinc primer, high-build elastomeric coatings, and galvanizing, for pinholes, holidays, and discontinuities, as manufactured by Tinker and Rasor, San Gabriel, CA, Model M-1.
3. Provide high-voltage spark tester to test completed coating systems in excess of 20 mils dry film thickness. Unit as recommended by coating manufacturer.

B. 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 RP0188.

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 RP0188.

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. Feather edges and repair in accordance with recommendations of paint manufacturer.
2. Hand or power sand visible areas of chipped, peeled, or abraded paint, and feather the edges. Follow with primer and finish coat. Depending on extent of repair and appearance, a finish sanding and topcoat may be required.
3. Apply finish coats, including touchup and damage-repair coats in a manner that will present a uniform texture and color-matched appearance.

3.11 MANUFACTURER'S SERVICES

A. In accordance with Section 01 43 33, Manufacturers' Field Services, coating manufacturer's representative shall be present at Site as follows:

1. On first day of application of any coating system.
2. A minimum of two additional Site inspection visits, each for a minimum of 4 hours, in order to provide Manufacturer's Certificate of Proper Installation.
3. As required to resolve field problems attributable to or associated with manufacturer's product.
4. To verify full cure of coating prior to coated surfaces being placed into immersion service.

3.12 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.

3.13 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

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

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 10 years manufacturing proposed products.

B. Applicator's Experience: Minimum 5 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 1 years 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. Ceilcoat Corrosion Control, Brecksville, OH.

B. Dudick, Inc., Streetsboro, OH.

C. Stonhard, Maple Shade, NJ.

2.02 SERVICE CONDITIONS

A. Location:

1. Chemical Building Chlorine Dioxide Bulk Chemical Storage: Outdoors, exposed to weather.
2. Chemical Building Chlorine Dioxide Room

B. Surface:

1. Chlorine Dioxide Bulk Chemical Storage: Concrete floors, walls, and sump for chemical storage and handling.

C. Traffic: Foot, light hand truck, forklifts.

D. Chemicals Stored in Containment Areas:

1. Sulfuric Acid, 78 percent solution.
2. Purate ($NaClO_3$+ ½ H_2O_2, 40 percent sodium chlorate and 10 percent hydrogen peroxide).

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. CRC-1: A mat-reinforced vinyl ester system. Primer, fiberglass mat, saturant, and two trowel-applied coats of vinyl ester resin with silica fillers. Finished system thickness 150 mils minimum.

C. CRC-2: A chemically-resistant, fiberglass-reinforced novolac vinyl ester lining system. Finished system thickness 150 mil minimum.

D. CRC-3: A chemically-resistant, fiberglass-reinforced bisphenol F novolac epoxy 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.

C. Concrete Surfaces:

1. Do not begin until 30 days after concrete has been placed.
2. Remove grease, oil, dirt, salts or other chemicals, loose materials, or other foreign matter by solvent, detergent, or other suitable cleaning methods.
3. Brushoff blast clean to remove loose concrete and provide a tooth for binding. Upon approval by Engineer, surface may be acid etched with muriatic acid solution. Approval, subject to producing desired profile.
4. Secure coating manufacturer's recommendations for additional preparation if required for excessive bug holes exposed after blasting.
5. Unless otherwise required for proper adhesion, ensure surfaces are dry prior to painting.

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 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: Use in the chlorine dioxide generation room.

C. Coating System CRC-2: Use in the Purate bulk storage and containment area.

D. Coating System CRC-3: Use in the sulfuric acid bulk storage and containment area.

E. Chemical Bulk Storage and Containment Area: Apply to horizontal and vertical surfaces up to and including tops and all sides of containment walls, tank pads, slabs, curbing, and inside drain and sump areas.

F. Interior Chemical Rooms: Apply to all horizontal and vertical surfaces, including both sides and tops of curbing, equipment pads, and inside drain and sump areas. On walls and columns, extend coating to six feet above building finished floor.

G. Interior Chemical Pipe Trenches: Apply to all horizontal and vertical surfaces within pipe trenches up to the normal finished floor level.

END OF SECTION

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.
   b. D709, Standard Specification for Laminated Thermosetting Materials.
3. The Chlorine Institute, Inc.: WC-1, Wall Chart: Handling Chlorine Cylinders and Ton Containers.
4. International Code Council (ICC):
   a. A117.1, Accessible and Usable Buildings and Facilities.
   b. International Fire Code (IFC): Chapter 27, Hazardous Materials-General Provisions.
5. 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.
6. Occupational Safety and Health Act (OSHA).
7. U.S. Department of Transportation, Federal Highway Administration: Manual on Uniform Traffic Control Devices for Streets and Highways.

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 PICTORIAL SYMBOLS

A. Material: Plastic with square corners.

B. Conform to ANSI A117.1, Section 4.30.

C. Manufacturers and Products:

1. Best Manufacturing Co., Kansas City, MO; System A-101.
2. Andco Industries Corp., Greensboro, NC; 1400 series.

2.02 SIGNS

A. Hazardous Material Sign (Type H):

1. Conform to NFPA 704 and NFPA HAZ-01.
2. Material: Fiberglass 1/8-inch thick.
3. Background, Letters, and Numbers: Die-cut vinyl with pressure sensitive adhesive.
4. Manufacturers:
   a. Brady Signmark.
   b. Emed Co., 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. Provided with ties or straps for pipes of 6 inches and over diameter.
3. Designed to firmly grip pipe so labels remain fixed in vertical pipe runs.
4. Material: Heavy-duty vinyl or polyester, suitable for exterior use, long lasting, and resistance to moisture, grease, and oils.
5. Letters and Arrows: Black on OSHA safety yellow background.
6. Color Field and Letter Height: Meet ASME A13.1.
7. Message: Piping system name as indicated on Piping Schedule.
8. Manufacturers and Products:
   a. Brady Signmark; B-915 BradySnap-On and Strap-On Pipe Markers.
   b. Seton Identification Products; Ultra-mark Pipe Markers.

B. Equipment Labels:

1. Applies to equipment with assigned tag numbers, where specified.
2. Letters: White engraved, 3/4-inch minimum high.

3. Background: Black.
4. Materials:
    a. Aluminum or stainless steel with a baked-on finish suitable for use on wet, oily, exposed, abrasive, and corrosive areas.
    b. Fiberglass with encased lettering.
5. Furnish 1-inch margin with holes at each end of label, for mounting. On fiberglass labels, furnish grommets at each hole.
6. Size:
    a. 2 inches minimum and 3 inches maximum high, by 14 inches minimum and 18 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. Brady Signmark.
    b. Seton Identification Products.

2.04 ANCILLARY MATERIALS

A. Fasteners: Stainless steel screws or bolts of appropriate sizes.

B. Wood Posts: Preservative treated 4 by 4 wood as specified.

C. Pipe Posts: 2-1/2-inch galvanized steel pipe meeting ASTM A53/A53M, Type S, Grade B.

D. Chain: Type 304 stainless steel, No. 16 single jack chain or No. 2 double loop coil chain.

E. Manufacturer’s standard brackets for wall mounting of two-sided exit signs.

PART 3 EXECUTION

3.01 INSTALLATION—GENERAL

A. In accordance with manufacturer’s recommendations.

B. Mount securely, plumb, and level.

3.02 DOOR NAMEPLATES AND PICTORIAL SYMBOLS

A. Attach to doors or walls adjacent to doors with Phillips head screws. See Door and Hardware 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, Exit, and Safety Signs: 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 27.
2. Install at entrances to spaces where hazardous materials are stored, dispensed, used, or handled, and on sides of stationary tanks.
3. Specific Materials:

Hazardous Materials					
Mark	**Material**	**Health Hazard (Blue)**	**Flammability Hazard (Red)**	**Instability Hazard (Yellow)**	**Special Hazard (White)**
H-7	Purate	2	0	2	OX
H-10	Sulfuric Acid (78% solution)	3	0	2	COR

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 each sign on Project. Provide items as scheduled. Meet requirements of Occupational Safety and Health Act (OSHA).
2. Sign Location Schedule.

END OF SECTION

Sign Schedule

Sign									Lettering					
			Size			Mounting								
No.[1]	Type[2]	Format[3]	Width	Height	Color	Location	Method	Height to Top	Height	Style	Color	Message	Faces	Other Requirements
C-1	C	1014-002	20"	14"	Yellow	Hanging	Chain	5'-6"	1" min.	Helvetica	Black	CAUTION Equipment Starts Automatically	1	
C-2	C	1014-002	20"	14"	Yellow	Wall	Bolts	5'-6"	1" min.	Helvetica	Black	CAUTION Ear Protection Required	1	
D-11[4]	C	1014 001	10’	7”	White	Door	Screws	5’6”	1” min	Helvetica	Black	DANGER CONFINED SPACE AUTHORIZED EMPLOYEES ONLY	1	
H-7	H	1014-006	10” min.	10” min.	*	At all doors or walls adjacent to doors entering area	Screws	5’6”	4”	Block	Black	*	1	* See format detail and Spec Article, Signs/Hazardous Materials Signals
H-10	H	1014-006	10” min.	10” min.	*	At all doors or walls adjacent to doors entering area	Screws	5’6”	4”	Block	Black	*	1	* See format detail and Spec Article, Signs/Hazardous Materials Signals

Sign Schedule

Sign									Lettering					
			Size			Mounting								
No.[1]	Type[2]	Format[3]	Width	Height	Color	Location	Method	Height to Top	Height	Style	Color	Message	Faces	Other Requirements
I-1	A	N/A	As required		White	Wall at each fill station	Bolts	5’-6”	1” min.	Helvetica	Black	*Chemical Fill Station	1	“Label with chemical associated with fill station
W-1	C	1014-003	20”	14”	Orange	Wall	Bolts	5’-6”	1” min	Helvetica	Black	WARNING Corrosive Materials Wear Required Protection	1	

[1]Numbers refer to a particular sign type with a particular message.
[2]Letters refer to sign types specified in this section.
[3]Numbers refer to Design Details that show sign layout.
[4]Verify requirements for this sign with Laws and Regulations in state where Project is located.

Sign Location Schedule				
Facility	**Sign No.**	**Applicable Equipment/Area**	**Quantity**	**Other Requirements**
Chemical Building	D-11	Chemical Tanks	2	Mount next to tank manway access
	H-7	Purate Hazard	3	Locate at each entrance to chemical area
	H-10	Sulfuric Acid Hazard	3	Locate at each entrance to chemical area
	I-1	Chemical Fill Station	1 for each fill connection	Locate on fill connection box
	W-1	Exterior Entrances to Chemical Building	4	
Filter Building	C-1 / C-2	Blower Room	1	

SECTION 13 34 26
FABRICATED CANOPIES

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): 301, Specifications for Structural Concrete for Buildings.
2. American Society of Civil Engineers (ASCE): 7, Minimum Design Loads for Buildings and Other Structures.
3. ASTM International (ASTM): A653, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
4. National Fire Protection Association (NFPA): 70, National Electrical Code.

1.02 SYSTEM DESCRIPTION

A. Canopy Name: Powdered activated carbon storage canopy.

1. Size: As shown on Drawings.
2. Roof Slope: As shown on Drawings.
3. Include: Anchorage to concrete, including embedment length, foundation, columns, roof framing, roof panels, eave trim, gutters, and downspouts.

B. System: Design, furnish, and install complete canopy package using manufacturer’s standard components.

C. Structure: All metal, prefabricated structure of steel frame design, fabricated from galvanized steel.

D. Design: Open sided canopy designed to protect stored powdered activated carbon from stormwater.

1.03 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
   a. Manufacturer’s Standard Details and Structural Calculations: Clearly mark those portions that apply to specific Project and those parts that do not apply.

b. Manufacturer's Literature and Technical Data: Drawings and Specifications for proposed canopy system.
c. Painting Systems: Specifications including paint manufacturer's name, product trade-name, and preparation for shop and field coats.
d. Drawings stamped by Contractor's engineer and prepared specifically for this Project:
1) Materials and Details: Show materials, details of components, finishes, fastenings, methods of joining, sealants, anchor bolts, shear angle, and anchorage and baseplate details, including all sizes and dimensions, size and location of structural members and bracing.
e. Calculations Stamped by Contractor's Engineer:
1) Complete structural stress and deflection analysis of structural components, connections, and anchorage; for bolted moment-resistant connections in main frames consider prying action of bolts.
2. Samples: Colors of metal available.

B. Informational Submittals:

1. Experience records of manufacturer and installer.
2. Approval of installer by manufacturer of structure components.
3. Certification that codes and referenced standards have been met.
4. Description and details of electrical continuity and grounding methods.
5. Test reports.

1.04 QUALITY ASSURANCE

A. Qualifications:

1. Designers: Engineers registered in state where building is to be erected.
2. Manufacturer:
a. At least 5 years' experience in work of the type required in this section.
b. Production capacity to provide work required for this Project without delay.
3. Erector/Installer:
a. Not less than 5 years' experience in the erection of prefabricated structures similar to this Project.
b. Approved by manufacturer of building components.

B. Regulatory Requirements: Design building system to meet requirements of 2012 International Building Code, as amended by the State of Georgia, and the Fayette County, GA Code of Ordinances.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Deliver building components in undamaged condition to Site only when ready for installation.

B. Protect products from damage and deterioration.

C. Handle products in accordance with manufacturers' instructions.

1.06 SPECIAL GUARANTEE

A. Provide 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 minimum period of 5 years and as stated below after the date of Substantial Completion. Duties and obligations for correction or removal and replacement of defective Work as specified in the General Conditions.

B. Conditions:

1. Finish on roof panels, eave trim, gutters, and downspouts will not chalk, crack, check blister, peel, flake, chip, or lose adhesion for 5 years.
2. Roofing will remain weathertight for 20 years.

PART 2 PRODUCTS

2.01 BUILDING SYSTEM MANUFACTURERS

A. Basis of Design: Parkline Canopies, www.parkline.com.

2.02 SYSTEM PERFORMANCE

A. Structural Loading: Design structure in accordance with ASCE 7 and the following.

1. Building: Own dead load.
2. Special Equipment: As shown on the Drawings.
3. Roof Snow Load: As shown on drawings, in accordance with applicable building code in Project area.
4. Design Wind Loads: As shown on Drawings in accordance with applicable building code in the Project area.
5. Earthquake Load: As shown on Drawings in accordance with applicable building code for Seismic Design Category D in the Project area.

2.03 COMPONENTS

A. Substructure: Cast-in-place concrete foundation.

B. Frame:

1. Roof Framing: 12 gauge cold formed galvanized members in accordance with Specification Section 05 50 00, where applicable.
2. Columns: Prime painted galvanized structural steel tube columns in accordance with Specification Section 05 50 00.
3. Anchorage: As specified in Section 01 88 15, Anchorage and Bracing and Specification Section 05 50 00, where applicable.
4. Finish: Field painted with Paint System No. 6 as specified in Section 09 90 00, Painting and Coating in color to be selected by Owner or Engineer.

C. Roof Panels:

1. Type: Flush standing seam steel panels.
2. Thickness: Nominal 24 gauge.
3. Width: 16 inches.
4. Finish:
   a. Galvanized steel conforming to ASTM A653 with galvanized coating conforming to G90 standards.
   b. Factory, roller applied paint coats having a combined coating thickness of 0.8 to 1.2 mils of dry film thickness of white siliconized polyester formulation.

D. Eave Trim, Gutters and Downspouts:

1. Thickness: Nominal 24-gauge steel.
2. Finish:
   a. Galvanized steel conforming to ASTM A653 with galvanized coating conforming to G90 standards.
   b. Manufacturers' standard finish in color to be selected by Owner or Engineer from standard color choices.

2.04 SOURCE QUALITY CONTROL

A. Inspections: Before shipment, inspect for complete, functional assembly.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine Site and access to determine effect on proposed canopy.

B. Investigate soils conditions and their effect on proposed canopy.

3.02 PREPARATION

A. Verify Site conditions and make necessary field measurements.

B. Perform Site modifications to suit installation of prefabricated canopy.

3.03 ERECTION

A. Erect structural components in accordance with manufacturer's instructions. Securely anchor to concrete foundation.

B. Provide for erection and wind loads. Provide temporary bracing to maintain structure plumb and in alignment until completion of permanent, stable structure.

C. Install materials following manufacturers' instructions and recommendations.

3.04 FIELD FINISHING

A. Columns and Roof Framing: Apply Paint System No. 6 as specified in Section 09 90 00, Painting and Coating.

3.05 ELECTRICAL SYSTEMS

A. Meet requirements of National Electrical Code, NFPA 70.

B. Provide grounding for building by connecting to the buried ground loop as indicated.

3.06 CLEANING

A. Thoroughly clean canopy and leave weathertight and ready for use.

3.07 PROTECTION

A. Protect installed products from damage.

END OF SECTION

SECTION 26 05 02
BASIC ELECTRICAL REQUIREMENTS

PART 1 GENERAL

1.01 RELATED SECTIONS

A. Requirements specified within this section apply to Division 26, Electrical. Work specified herein shall be performed as if specified in the individual sections.

1.02 REFERENCES

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

1. National Electrical Contractors Association (NECA): National Electrical Installation Standards.
2. National Electrical Manufacturers Association (NEMA):
   a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
   b. Z535.4, Product Safety Signs and Labels.
3. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC).
4. Underwriters Laboratories, Inc. (UL).

1.03 SUBMITTALS

A. Action Submittals: Provide manufacturers' data for nameplates, signs, and labels.

1.04 QUALITY ASSURANCE

A. Provide the Work in accordance with NFPA 70. Where required by 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.

C. Provide materials and equipment acceptable to AHJ for class, division, and group of hazardous area indicated.

1.05 ENVIRONMENTAL CONDITIONS

A. See the Drawings for environmental requirements pertaining to electrical work elements and equipment.

PART 2 PRODUCTS

2.01 GENERAL

A. Where two or more units of the same class of material or equipment are required, provide products of a single manufacturer. Component parts of materials or equipment need not be products of the same manufacturer.

B. Material and equipment installed in heated and ventilated areas shall be capable of continuous operation at their specified ratings within an ambient temperature range of 40 to 104 degrees F.

C. Materials and equipment installed outdoors or in unheated enclosures shall be capable of continuous operation at their specified rating within the ambient temperature range of 10 to 100 degrees F.

2.02 EQUIPMENT FINISH

A. Manufacturer’s standard finish color, except where specific color is indicated. If manufacturer has no standard color, finish equipment in accordance with, light gray color finish as approved by Owner.

2.03 NAMEPLATES

A. Material: Laminated plastic.

B. Attachment Screws: Stainless steel.

C. Color: White, engraved to a black core.

D. Letter Height:

1. Pushbuttons/Selector Switches: 1/8 inch.
2. Other electrical equipment: 1/4 inch.

2.04 SIGNS AND LABELS

A. Sign size, lettering, and color shall be in accordance with NEMA Z535.4.

PART 3 EXECUTION

3.01 GENERAL

A. Electrical Drawings show general locations of equipment, devices, and raceway, unless specifically dimensioned. Contractor shall be responsible for actual location of equipment and devices and for proper routing and support of raceways, subject to approval of Engineer.

B. Check approximate locations of light fixtures, switches, electrical outlets, equipment, and other electrical system components shown on Drawings for conflicts with openings, structural members, and components of other systems and equipment having fixed locations. In the event of conflicts, notify Engineer in writing.

C. Install work in accordance with NECA Standard of Installation, unless otherwise specified.

D. Keep openings in boxes and equipment closed during construction.

E. Lay out work carefully in advance. Do not cut or notch any structural member or building surface without specific approval of Engineer. Carefully perform cutting, channeling, chasing, or drilling of floors, walls, partitions, ceilings, paving, or other surfaces required for the installation, support, or anchorage of conduit, raceways, or other electrical materials and equipment. Following such work, restore surfaces to original condition.

3.02 ANCHORING AND MOUNTING

A. Equipment anchoring and mounting shall be in accordance with manufacturer’s requirements for seismic zone criteria given in Section 01 88 15, Anchorage and Bracing.

3.03 COMBINING CIRCUITS INTO COMMON RACEWAY

A. Drawings show each homerun circuit to be provided. Do not combine power or control circuits into common raceways without authorization of Engineer.

3.04 NAMEPLATES, SIGNS, AND LABELS

A. Arc Flash Protection Warning Signs:

1. Field mark switchboards, motor control centers, panelboards, AFDs, and 480V motor starting control panels to warn qualified persons of potential arc-flash hazards. Locate marking so to be clearly visible to persons before working on energized equipment.

2. Use arc flash hazard boundary, energy level, PPE level and description, shock hazard, bolted fault current, and equipment name from study required in Section 26 05 70, Electrical Systems Analysis as basis for warning signs.

B. Equipment Nameplates:

1. Provide a nameplate to label electrical equipment including switchgear, switchboards, motor control centers, panelboards, motor starters, transformers, terminal junction boxes, disconnect switches, switches and control stations.
2. Switchgear, motor control center, transformer, and terminal junction box nameplates shall include equipment designation.
3. Disconnect switch, starter, and control station nameplates shall include name and number of equipment powered or controlled by that device.
4. Switchboard and panelboard nameplates shall include equipment designation, service voltage, and phases.

3.05 LOAD BALANCE

A. Drawings and Specifications indicate circuiting to electrical loads and distribution equipment.

B. Balance electrical load between phases as nearly as possible on switchboards, panelboards, motor control centers, and other equipment where balancing is required.

C. When loads must be reconnected to different circuits to balance phase loads, maintain accurate record of changes made, and provide circuit directory that lists final circuit arrangement.

3.06 CLEANING AND TOUCHUP PAINTING

A. Cleaning: Throughout the Work, clean interior and exterior of devices and equipment by removing debris and vacuuming.

B. Touchup Paint:

1. Touchup scratches, scrapes and chips on exterior and interior surfaces of devices and equipment with finish matching type, color, and consistency and type of surface of original finish.
2. If extensive damage is done to equipment paint surfaces, refinish entire equipment in a manner that provides a finish equal to or better than factory finish, that meets requirements of Specification, and is acceptable to Engineer.

3.07 PROTECTION FOLLOWING INSTALLATION

A. Protect materials and equipment from corrosion, physical damage, and effects of moisture on insulation and contact surfaces.

B. When equipment intended for indoor installation is installed at Contractor's convenience in areas where subject to dampness, moisture, dirt or other adverse atmosphere until completion of construction, ensure adequate protection from these atmospheres is provided and acceptable to Engineer.

END OF SECTION

SECTION 26 05 04
BASIC ELECTRICAL MATERIALS AND METHODS

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. A167, Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.
   b. A1011/A1011M, Standard Specification for Steel, Sheet, and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low Alloy and High-Strength Low Alloy Formability.
   c. E814, Method of Fire Tests of Through-Penetration Fire Stops.
2. Canadian Standards Association (CSA).
3. Institute of Electrical and Electronics Engineers, Inc. (IEEE): 18, Standard for Shunt Power Capacitors.
4. International Society of Automation (ISA): RP12.06.01, Wiring Practices for Hazardous (Classified) Locations Instrumentation–Part 1: Intrinsic Safety.
5. National Electrical Manufacturers Association (NEMA):
   a. 250, Enclosures for Electrical Equipment (1,000 Volts Maximum).
   b. AB 1, Molded Case Circuit Breakers, Molded Case Switches, and Circuit-Breaker Enclosures.
   c. C12.1 Code for Electricity Metering.
   d. C12.6 Phase-Shifting Devices Used in Metering, Marking and Arrangement of, Terminals for.
   e. CP 1, Shunt Capacitors.
   f. ICS 2, Industrial Control and Systems: Controllers, Contactors, and Overload Relays Rated 600 Volts.
   g. ICS 5, Industrial Control and Systems: Control Circuit and Pilot Devices.
   h. KS 1, Enclosed and Miscellaneous Distribution Switches (600 Volts Maximum).
6. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC).
7. Underwriters Laboratories Inc. (UL):
   a. 98, Standard for Enclosed and Dead-Front Switches.
   b. 248, Standard for Low Voltage Fuses.
   c. 486E, Standard for Equipment Wiring Terminals for use with Aluminum and/or Copper Conductors.
   d. 489, Standard for Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit Breaker Enclosures.

e. 508, Standard for Industrial Control Equipment.
f. 810, Standard for Capacitors.
g. 943, Standard for Ground-Fault Circuit-Interrupters.
h. 1059, Standard for Terminal Blocks.
i. 1479, Fire Tests of Through-Penetration Fire Stops.

1.02 SUBMITTALS

A. Action Submittals:

1. Provide manufacturers' data for the following:
   a. Control devices.
   b. Control relays.
   c. Circuit breakers.
   d. Fused switches.
   e. Nonfused switches.
   f. Timers.
   g. Fuses.
   h. Magnetic contactors.
   i. Firestopping.
   j. Enclosures: Include enclosure data for products having enclosures.
2. Seismic anchorage and bracing drawings and cut sheets, as required by Section 01 88 15, Anchorage and Bracing.

B. Informational Submittals: Seismic anchorage and bracing calculations as required by Section 01 88 15, Anchorage and Bracing.

1.03 EXTRA MATERIALS

A. Furnish, tag, and box for shipment and storage the following spare parts and special tools:

1. Fuses, 0 to 600 Volts: Six of each type and each current rating installed.

PART 2 PRODUCTS

2.01 MOLDED CASE CIRCUIT BREAKER THERMAL MAGNETIC, LOW VOLTAGE

A. General:

1. Type: Molded case.
2. Trip Ratings: 15-800 amps.
3. Voltage Ratings: 120, 240, 277, 480, and 600V ac.
4. Suitable for mounting and operating in any position.
5. NEMA AB 1 and UL 489.

B. Operating Mechanism:

1. Overcenter, trip-free, toggle type handle.
2. Quick-make, quick-break action.
3. Locking provisions for padlocking breaker in open position.
4. ON/OFF and TRIPPED indicating positions of operating handle.
5. Operating handle to assume a center position when tripped.

C. Trip Mechanism:

1. Individual permanent thermal and magnetic trip elements in each pole.
2. Variable magnetic trip elements with a single continuous adjustment 3X to 10X for frames greater than 100 amps.
3. Two and three pole, common trip.
4. Automatically opens all poles when overcurrent occurs on one pole.
5. Test button on cover.
6. Calibrated for 40 degrees C ambient, unless shown otherwise.
7. Do not provide single-pole circuit breakers with handle ties where multi-pole circuit breakers are shown.

D. Short Circuit Interrupting Ratings:

1. Equal to, or greater than, available fault current or interrupting rating shown.
2. Series Connected Ratings: Do not apply series connected short circuit ratings.

E. Ground Fault Circuit Interrupter (GFCI): Where indicated, equip breaker as specified above with ground fault sensor and rated to trip on 5-mA ground fault within 0.025 second (UL 943, Class A sensitivity, for protection of personnel).

1. Ground fault sensor shall be rated same as circuit breaker.
2. Push-to-test button.

F. Equipment Ground Fault Interrupter (EGFI): Where indicated, equip breaker specified above with ground fault sensor and rated to trip on 30-mA ground fault (UL-listed for equipment ground fault protection).

G. Magnetic Only Type Breakers: Where shown; instantaneous trip adjustment which simultaneously sets magnetic trip level of each individual pole continuously through a 3X to 10X trip range.

H. Accessories: Shunt trip, auxiliary switches, handle lock ON devices, mechanical interlocks, key interlocks, unit mounting bases, double lugs as shown or otherwise required. Shunt trip operators shall be continuous duty rated or have coil-clearing contacts.

I. Connections:

1. Supply (line side) at either end.
2. Mechanical wire lugs, except crimp compression lugs where shown.
3. Lugs removable/replaceable for breaker frames greater than 100 amperes.
4. Suitable for 75 degrees C rated conductors without derating breaker or conductor ampacity.
5. Use bolted bus connections, except where bolt-on is not compatible with existing breaker provisions.

J. Enclosures for Independent Mounting:

1. See Article Enclosures.
2. Service Entrance Use: Breakers in required enclosure and required accessories shall be UL 489 listed.
3. Interlock: Enclosure and switch shall interlock to prevent opening cover with switch in the ON position. Provide bypass feature for use by qualified personnel.

2.02 FUSED SWITCH, INDIVIDUAL, LOW VOLTAGE

A. UL 98 listed for use and location of installation.

B. NEMA KS 1.

C. Short Circuit Rating: 200,000 amps RMS symmetrical with Class R, Class J, or Class L fuses installed.

D. Quick-make, quick-break, motor rated, load-break, heavy-duty (HD) type with external markings clearly indicating ON/OFF positions.

E. Connections:

1. Mechanical lugs, except crimp compression lugs where shown.
2. Lugs removable/replaceable.
3. Suitable for 75 degrees C rated conductors at NEC 75 degrees C ampacity.

F. Fuse Provisions:

1. 30-amp to 600-amp rated shall incorporate rejection feature to reject all fuses except Class R.
2. 601-amp rated and greater shall accept Class L fuses, unless otherwise shown.

G. Enclosures: See Article Enclosures.

H. Interlock: Enclosure and switch to prevent opening cover with switch in ON position. Provide bypass feature for use by qualified personnel.

2.03 NONFUSED SWITCH, INDIVIDUAL, LOW VOLTAGE

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. Lugs: Suitable for use with 75 degrees C wire at NEC 75 degrees C ampacity.

D. Auxiliary Contact:

1. Operation: Make before power contacts make and break before power contacts break.
2. Contact Rating: 7,200VA make, 720VA break, at 600V, NEMA ICS 5 Designation A600.
3. Provide as indicated.

E. Enclosures: See Article Enclosures.

F. Interlock: Enclosure and switch to prevent opening cover with switch in ON position. Provide bypass feature for use by qualified personnel.

2.04 FUSE, 250-VOLT AND 600-VOLT

A. Power Distribution, General:

1. Current-limiting, with 200,000 ampere rms interrupting rating.
2. Provide to fit mountings specified with switches.
3. UL 248.

B. Power Distribution, Ampere Ratings 1 Amp to 600 Amps:

1. Class: RK-1.
2. Type: Dual element, with time delay.
3. Manufacturers and Products:
   a. Bussmann; Types LPS-RK (600 volts) and LPN-RK (250 volts).
   b. Littelfuse, Inc.; Types LLS-RK (600 volts) and LLN-RK (250 volts).

C. Ferrule:

1. 600V or less, rated for applied voltage, small dimension.
2. Ampere Ratings: 1/10 amp to 30 amps.
3. Dual-element time-delay, time-delay, or nontime-delay as required.

4. Provide with blocks or holders as indicated and suitable for location and use.
5. Manufacturers:
   a. Bussmann.
   b. Littelfuse, Inc.

2.05 PUSHBUTTON, INDICATING LIGHT, AND SELECTOR SWITCH

A. Contact Rating: 7,200VA make, 720VA break, at 600V, NEMA ICS 5 Designation A600.

B. Selector Switch Operating Lever: Standard.

C. Indicating Light: LED, full voltage.

D. Pushbutton Color:

1. ON or START: Black.
2. OFF or STOP: Red.

E. Pushbutton and selector switch lockable in OFF position where indicated.

F. Legend Plate:

1. Material: Aluminum.
2. Engraving: Enamel filled in high contrasting color.
3. Text Arrangement: 11-character/spaces on one line, 14-character/spaces on each of two lines, as required, indicating specific function.
4. Letter Height: 7/64-inch.

G. Manufacturers and Products:

1. Heavy-Duty, Oil-Tight Type:
   a. General Electric Co.; Type CR 104P.
   b. Square D Co.; Type T.
   c. Eaton/Cutler-Hammer; Type 10250T.
2. Heavy-Duty, Watertight, and Corrosion-Resistant Type:
   a. Square D Co.; Type SK.
   b. General Electric Co.; Type CR 104P.
   c. Eaton/Cutler-Hammer; Type E34.
   d. Crouse-Hinds; Type NCS.

2.06 TERMINAL BLOCK, 600 VOLTS

A. UL 486E and UL 1059.

B. Size components to allow insertion of necessary wire sizes.

C. Capable of termination of control circuits entering or leaving equipment, panels, or boxes.

D. Screw clamp compression, dead front barrier type, with current bar providing direct contact with wire between compression screw and yoke.

E. Yoke, current bar, and clamping screw of high strength and high conductivity metal.

F. Yoke shall guide all strands of wire into terminal.

G. Current bar shall ensure vibration-proof connection.

H. Terminals:

1. Capable of wire connections without special preparation other than stripping.
2. Capable of jumper installation with no loss of terminal or rail space.
3. Individual, rail mounted.

I. Marking system, allowing use of preprinted or field-marked tags.

J. Manufacturers:

1. Weidmuller, Inc.
2. Ideal.
3. Electrovert USA Corp.

2.07 MAGNETIC CONTROL RELAY

A. Industrial control with field convertible contacts rated 10 amps continuous, 7,200VA make, 720VA break.

B. NEMA ICS 2, Designation: A600 (600 volts).

C. Latching Attachment: Mechanical latch, having unlatching coil and coil clearing contacts.

D. Manufacturers and Products:

1. Eaton/Cutler-Hammer; Type M-600.
2. General Electric Co.; Type CR120B.

2.08 TIME DELAY RELAY

A. Industrial relay with contacts rated 5 amps continuous, 3,600VA make, 360VA break.

B. NEMA ICS 2 Designation: B150 (150 volts).

C. Solid-state electronic, field convertible ON/OFF delay.

D. One normally open and one normally closed contact (minimum).

E. Repeat accuracy plus or minus 2 percent.

F. Timer adjustment from 1 second to 60 seconds, unless otherwise indicated on Drawings.

G. Manufacturers and Products:

1. Square D Co.; Type F.
2. Eaton/Cutler-Hammer.
3. General Electric Co.

2.09 RESET TIMER

A. Drive: Synchronous motor, solenoid-operated clutch.

B. Mounting: Semiflush panel.

C. Contacts: 10 amps, 120 volts.

D. Manufacturers and Products:

1. Eagle Signal Controls; Bulletin 125.
2. Automatic Timing and Controls; Bulletin 305.

2.10 ELAPSED TIME METER

A. Drive: Synchronous motor.

B. Range: 0 to 99,999.9 hours, nonreset type.

C. Mounting: Semiflush panel.

D. Manufacturers and Products:

1. General Electric Co.; Type 240, 2-1/2-inch Big Look.
2. Eagle Signal Controls; Bulletin 705.

2.11 MAGNETIC LIGHTING CONTACTOR

A. Comply with NEMA ICS 2; provide UL 508 listing.

B. Electrically operated by dual-acting, single coil mechanism.

C. Inherently interlocked and mechanically held in both OPEN and CLOSED position.

D. Main Contacts:

1. Double-break, continuous-duty, rated 30 amperes, 600 volts, withstand rating of 22,000 amps rms symmetrical at 250 volts.
2. 65,000 amps rms symmetrical at 480 volts.
3. Marked for electric discharge lamps, tungsten, and general purpose loads.
4. Position not dependent on gravity, hooks, latches, or semipermanent magnets.
5. Capable of operating in any position.
6. Visual indication for each contact.

E. Auxiliary contact relay for two-wire control.

F. One normally open and one normally closed auxiliary contact rated 10 amperes continuous, 7,200VA make, 720VA break with NEMA designation of A600 (600 volts).

G. Fully rated neutral terminal.

H. Provision for remote pilot lamp with use of auxiliary contacts.

I. Clamp type, self-rising terminal plates for solderless connections.

J. Enclosures: See Article Enclosures.

K. Manufacturers and Products:

1. ASCO.
2. Eaton/Cutler-Hammer; Class A202.
3. General Electric Co.; Class CR360 (mechanically held).
4. Square D; Class 8903, Type LL (mechanically held).

2.12 SUPPORT AND FRAMING CHANNELS

A. Carbon Steel Framing Channel:

1. Material: Rolled, mild strip steel, 12-gauge minimum, ASTM A1011/A1011M, Grade 33.
2. Finish: Hot-dip galvanized after fabrication.

B. Paint Coated Framing Channel: Carbon steel framing channel with electro-deposited rust inhibiting acrylic or epoxy paint.

C. PVC Coated Framing Channel: Carbon steel framing channel with 40-mil polyvinyl chloride coating.

D. Stainless Steel Framing Channel: Rolled, ASTM A167, Type 316 stainless steel, 12-gauge minimum.

E. Extruded Aluminum Framing Channel:

1. Material: Extruded from Type 6063-T6 aluminum alloy.
2. Fittings fabricated from Alloy 5052-H32.

F. Nonmetallic Framing Channel:

1. Material: Fire retardant, fiber reinforced vinyl ester resin.
2. Channel fitting of same material as channel.
3. Nuts and bolts of long glass fiber reinforced polyurethane.

G. Manufacturers:

1. B-Line Systems, Inc.
2. Unistrut Corp.
3. Aickinstrut.

2.13 FIRESTOPS

A. General:

1. Provide UL 1479 classified hourly fire-rating equal to, or greater than, the assembly penetrated.
2. Prevent the passage of cold smoke, toxic fumes, and water before and after exposure to flame.
3. Sealants and accessories shall have fire-resistance ratings as established by testing identical assemblies in accordance with ASTM E814, by Underwriters Laboratories Inc., or other testing and inspection agency acceptable to authorities having jurisdiction.

B. Firestop System:

1. Formulated for use in through-penetration firestopping around cables, conduit, pipes, and duct penetrations through fire-rated walls and floors.
2. Fill, Void, or Cavity Material: 3M Brand Fire Barrier Caulk CP25, Putty 303, Wrap/Strip FS195, Composite Sheet CS195 and Penetration Sealing Systems 7902 and 7904 Series.
3. Two-Part, Foamed-In-Place, Silicone Sealant: Dow Corning Corp. Fire Stop Foam, General Electric Co. Pensil 851.
4. Fire Stop Devices: See Section 26 05 33, Raceway and Boxes, for raceway and cable fittings.

2.14 ENCLOSURES

A. Finish: Sheet metal structural and enclosure parts shall be completely painted using an electrodeposition process so interior and exterior surfaces as well as bolted structural joints have a complete finish coat on and between them.

B. Color: Manufacturer's standard color (gray) baked-on enamel, unless otherwise shown.

C. Barriers: Provide metal barriers within enclosures to separate wiring of different systems and voltage.

D. Enclosure Selections: Except as shown otherwise, provide electrical enclosures according to the following table:

ENCLOSURES			
Location	**Finish**	**Environment**	**NEMA 250 Type**
Indoor	Finished	Dry	1
Indoor	Unfinished	Dry	1
Indoor	Unfinished	Industrial use	12
Indoor and outdoor	Any	Wet	4X Type 304 stainless steel
Indoor and outdoor	Any	Wet and corrosive	4X Type 304 stainless steel

PART 3 EXECUTION

3.01 GENERAL

A. Install equipment in accordance with manufacturer's recommendations.

3.02 PUSHBUTTON, INDICATING LIGHT, AND SELECTOR SWITCH

A. Unless otherwise shown, install heavy-duty, oil-tight type in nonhazardous, indoor, dry locations, including motor control centers, control panels, and individual stations.

B. Unless otherwise shown, install heavy-duty, watertight and corrosion-resistant type in nonhazardous, outdoor, or normally wet areas.

3.03 SUPPORT AND FRAMING CHANNEL

A. Install where required for mounting and supporting electrical equipment, raceway, and cable tray systems.

B. Channel Type:

1. Interior, Wet or Dry (Noncorrosive) Locations:
   a. Aluminum Raceway: Extruded aluminum.
   b. PVC-Coated Conduit: PVC coated.
   c. Steel Raceway and Other Systems Not Covered: Carbon steel or paint coated.
2. Interior, Corrosive (Wet or Dry) Locations:
   a. Aluminum Raceway: Extruded aluminum.
   b. PVC Conduit: Type 316 stainless steel or nonmetallic.
   c. PVC-Coated Steel Conduit and Other Systems Not Covered: Type 316 stainless steel, nonmetallic, or PVC-coated steel.
3. Outdoor, Noncorrosive Locations:
   a. Steel Raceway: Carbon steel or paint coated framing channel, except where mounted on aluminum handrail, then use aluminum framing channel.
   b. Aluminum Raceway and Other Systems Not Covered: Aluminum framing channel.
4. Outdoor Corrosive Locations:
   a. PVC Conduit: Type 316 stainless steel or nonmetallic.
   b. Aluminum Raceway: Aluminum.
   c. PVC-Coated Steel Conduit and Other Systems Not Covered: Type 316 stainless steel, nonmetallic, or PVC coated steel.

C. Paint cut ends prior to installation with the following:

1. Carbon Steel Channel: Zinc-rich primer.
2. Painted Channel: Rust-inhibiting epoxy or acrylic paint.
3. Nonmetallic Channel: Epoxy resin sealer.
4. PVC-Coated Channel: PVC patch.

3.04 FIRESTOPS

A. Install in strict conformance with manufacturer’s instructions. Comply with installation requirements established by testing and inspecting agency.

B. Sealant: Install sealant, including forming, packing, and other accessory materials, to fill openings around electrical services penetrating floors and walls, to provide firestops with fire-resistance ratings indicated for floor or wall assembly in which penetration occurs.

END OF SECTION

SECTION 26 05 05
CONDUCTORS

PART 1 GENERAL

1.01 REFERENCES

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

1. Association of Edison Illuminating Companies (AEIC): CS 8, Specification for Extruded Dielectric Shielded Power Cables Rated 5 kV through 46 kV.
2. ASTM International (ASTM):
   a. A167, Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.
   b. B3, Standard Specification for Soft or Annealed Copper Wire.
   c. B8, Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft.
   d. B496, Standard Specification for Compact Round Concentric-Lay-Stranded Copper Conductors.
3. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
   a. 48, Standard Test Procedures and Requirements for Alternating-Current Cable Terminations Used on Shielded Cables Having Laminated Insulation Rated 2.5 kV through 765 kV or Extruded Insulation Rated 2.5 kV Through 500 kV.
   b. 386, Standard for Separable Insulated Connector Systems for Power Distribution Systems Above 600V.
   c. 404, Standard for Extruded and Laminated Dielectric Shielded Cable Joints Rated 2500 V to 500000 V.
4. Insulated Cable Engineer's Association, Inc. (ICEA):
   a. S-58-679, Standard for Control Cable Conductor Identification.
   b. S-73-532, Standard for Control Thermocouple Extensions and Instrumentation Cables.
   c. T-29-520, Conducting Vertical Cable Tray Flame Tests with Theoretical Heat Input of 210,000 Btu/hour.
5. National Electrical Manufacturers' Association (NEMA):
   a. CC 1, Electric Power Connectors for Substations.
   b. WC 57, Standard for Control, Thermocouple Extension, and Instrumentation Cables.
   c. WC 70, Standard for Power Cables Rated 2000 Volts or Less for the Distribution of Electrical Energy.
   d. WC 71, Standard for Nonshielded Cables Rated 2001-5000 Volts for Use in the Distribution of Electric Energy.
   e. WC 74, 5-46 kV Shielded Power Cable for Use in the Transmission and Distribution of Electric Energy.

6. National Fire Protection Association (NFPA):
   a. 70, National Electrical Code (NEC).
   b. 262, Standard Method of Test for Flame Travel and Smoke of Wires and Cables for Use in Air-Handling Spaces.
7. Telecommunications Industry Association (TIA): TIA-568-C, Commercial Building Telecommunications Cabling Standard.
8. Underwriters Laboratories Inc. (UL):
   a. 13, Standard for Safety for Power-Limited Circuit Cables.
   b. 44, Standard for Safety for Thermoset-Insulated Wires and Cables.
   c. 62, Standard for Safety for Flexible Cord and Cables.
   d. 486A-486B, Standard for Safety for Wire Connectors.
   e. 486C, Standard for Safety for Splicing Wire Connectors.
   f. 510, Standard for Safety for Polyvinyl Chloride, Polyethylene, and Rubber Insulating Tape.
   g. 854, Standard for Safety for Service-Entrance Cables.
   h. 1072, Standard for Safety for Medium-Voltage Power Cables.
   i. 1277, Standard for Safety for Electrical Power and Control Tray Cables with Optional Optical-Fiber Members.
   j. 1569, Standard for Safety for Metal-Clad Cables.
   k. 1581, Standard for Safety for Reference Standard for Electrical Wires, Cables, and Flexible Cords.

1.02 SUBMITTALS

A. Action Submittals:

1. Product Data:
   a. Wire and cable.
   b. Wire and cable accessories.

1.03 QUALITY ASSURANCE

A. Authority Having Jurisdiction (AHJ):

1. Provide the Work in accordance with NFPA 70. 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 UL shall conform to those standards and shall have an applied UL listing mark.

PART 2 PRODUCTS

2.01 CONDUCTORS 600 VOLTS AND BELOW

A. Conform to applicable requirements of NEMA WC 70.

B. Conductor Type:

1. 120-Volt and 277-Volt Lighting, 10 AWG and Smaller: Solid copper.
2. 120-Volt Receptacle Circuits, 10 AWG and Smaller: Solid copper.
3. All Other Circuits: Stranded copper.

C. Insulation: Type THHN/THWN-2, except for sizes No. 6 and larger, with XHHW-2 insulation.

D. Direct Burial and Aerial Conductors and Cables:

1. Type USE/RHH/RHW insulation, UL 854 listed, or Type RHW-2/USE-2.
2. Conform to physical and minimum thickness requirements of NEMA WC 70.

E. Flexible Cords and Cables:

1. Type SOW-A/50 with ethylene propylene rubber insulation in accordance with UL 62.
2. Conform to physical and minimum thickness requirements of NEMA WC 70.

2.02 600-VOLT RATED CABLE

A. General:

1. Type TC, meeting requirements of UL 1277, including Vertical Tray Flame Test at 70,000 Btu per hour, and NFPA 70, Article 340, or UL 13 meeting requirements of NFPA 70, Article 725.
2. Permanently and legibly marked with manufacturer’s name, maximum working voltage for which cable was tested, type of cable, and UL listing mark.
3. Suitable for installation in open air, in cable trays, or conduit.
4. Minimum Temperature Rating: 90 degrees C dry locations, 75 degrees C wet locations.
5. Overall Outer Jacket: PVC, flame-retardant, sunlight- and oil-resistant.

B. Type 1, Multiconductor Control Cable:

1. Conductors:
   a. 14 AWG, seven-strand copper.
   b. Insulation: 15-mil PVC with 4-mil nylon.
   c. UL 1581 listed as Type THHN/THWN rated VW-1.
   d. Conductor group bound with spiral wrap of barrier tape.
   e. Color Code: In accordance with ICEA S-58-679, Method 1, Table 2.
2. Cable: Passes the ICEA T-29-520, 210,000 Btu per hour Vertical Tray Flame Test.
3. Cable Sizes:

No. of Conductors	Max. Outside Diameter (Inches)	Jacket Thickness (Mils)
3	0.41	45
5	0.48	45
7	0.52	45
12	0.72	60
19	0.83	60
25	1.00	60
37	1.15	80

4. Manufacturers:
   a. Okonite Co.
   b. Southwire.

C. Type 3, 16 AWG, Twisted, Shielded Pair, Instrumentation Cable: Single pair, designed for noise rejection for process control, computer, or data log applications meeting NEMA WC 57 requirements.

1. Outer Jacket: 45-mil nominal thickness.
2. Individual Pair Shield: 1.35-mil, double-faced aluminum/synthetic polymer overlapped to provide 100 percent coverage.
3. Dimension: 0.31-inch nominal OD.
4. Conductors:
   a. Bare soft annealed copper, Class B, seven-strand concentric, meeting requirements of ASTM B8.
   b. 20 AWG, seven-strand tinned copper drain wire.
   c. Insulation: 15-mil nominal PVC.
   d. Jacket: 4-mil nominal nylon.
   e. Color Code: Pair conductors, black and red.

5. Manufacturers:
   a. Okonite Co.
   b. Alpha Wire Corp.
   c. Belden.

D. Type 4, 16 AWG, Twisted, Shielded Triad Instrumentation Cable: Single triad, designed for noise rejection for process control, computer, or data log applications meeting NEMA WC 57 requirements.

1. Outer Jacket: 45-mil nominal.
2. Individual Pair Shield: 1.35-mil, double-faced aluminum/synthetic polymer, overlapped to provide 100 percent coverage.
3. Dimension: 0.32-inch nominal OD.
4. Conductors:
   a. Bare soft annealed copper, Class B, seven-strand concentric, meeting requirements of ASTM B8.
   b. 20 AWG, seven-strand, tinned copper drain wire.
   c. Insulation: 15-mil nominal PVC.
   d. Jacket: 4-mil nylon.
   e. Color Code: Triad conductors black, red, and blue.
5. Manufacturers:
   a. Okonite Co.
   b. Alpha Wire Corp.
   c. Belden.

2.03 SPECIAL CABLES

A. Type 30, Unshielded Twisted Pair (UTP) Telephone and Data Cable, 300V:

1. Category 6 UTP, UL listed, and third party verified to comply with TIA/EIA 568-C Category 6 requirements.
2. 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.
3. Provide four each individually twisted pair, 23 AWG conductors, with FEP insulation and blue PVC jacket.
4. NFPA 70 Plenum (CMP) rated; comply with flammability plenum requirements of NFPA 70 and NFPA 262.
5. Cable shall withstand a bend radius of 1-inch minimum at a temperature of minus 20 degrees C maximum without jacket or insulation cracking.
6. Manufacturer and Product: Belden; 7852A.

2.04 GROUNDING CONDUCTORS

A. Equipment: Stranded copper with green, Type USE/RHH/RHW-XLPE or THHN/THWN, insulation.

B. Direct Buried: Bare stranded copper.

2.05 ACCESSORIES FOR CONDUCTORS 600 VOLTS AND BELOW

A. Tape:

1. General Purpose, Flame Retardant: 7-mil, vinyl plastic, Scotch Brand 33+, rated for 90 degrees C minimum, meeting requirements of UL 510.
2. Flame Retardant, Cold and Weather Resistant: 8.5-mil, vinyl plastic, Scotch Brand 88.
3. Arc and Fireproofing:
   a. 30-mil, elastomer.
   b. Manufacturers and Products:
      1) 3M; Scotch Brand 77, with Scotch Brand 69 glass cloth tapebinder.
      2) Plymouth; 53 Plyarc, with 77 Plyglas glass cloth tapebinder.

B. Identification Devices:

1. Sleeve:
   a. Permanent, PVC, yellow or white, with legible machine-printed black markings.
   b. Manufacturers and Products:
      1) Raychem; Type D-SCE or ZH-SCE.
      2) Brady, Type 3PS.
2. Heat Bond Marker:
   a. Transparent thermoplastic heat bonding film with acrylic pressure sensitive adhesive.
   b. Self-laminating protective shield over text.
   c. Machine printed black text.
   d. Manufacturer and Product: 3M Co.; Type SCS-HB.
3. Marker Plate: Nylon, with legible designations permanently hot stamped on plate.
4. Tie-On Cable Marker Tags:
   a. Chemical-resistant white tag.
   b. Size: 1/2 inch by 2 inches.
   c. Manufacturer and Product: Raychem; Type CM-SCE.
5. Grounding Conductor: Permanent green heat-shrink sleeve, 2-inch minimum.

C. Connectors and Terminations:

1. Nylon, Self-Insulated Crimp Connectors:
   a. Manufacturers and Products:
      1) Thomas & Betts; Sta-Kon.
      2) Burndy; Insulug.
      3) ILSCO.
2. Nylon, Self-Insulated, Crimp Locking-Fork, Torque-Type Terminator:
   a. Suitable for use with 75 degrees C wire at full NFPA 70, 75 degrees C ampacity.
   b. Seamless.
   c. Manufacturers and Products:
      1) Thomas & Betts; Sta-Kon.
      2) Burndy; Insulink.
      3) ILSCO; ILSCONS.
3. Self-Insulated, Freespring Wire Connector (Wire Nuts):
   a. UL 486C.
   b. Plated steel, square wire springs.
   c. Manufacturers and Products:
      1) Thomas & Betts.
      2) Ideal; Twister.
4. Self-Insulated, Set Screw Wire Connector:
   a. Two piece compression type with set screw in brass barrel.
   b. Insulated by insulator cap screwed over brass barrel.
   c. Manufacturers:
      1) 3M Co.
      2) Thomas & Betts.
      3) Marrette.

D. Cable Lugs:

1. In accordance with NEMA CC 1.
2. Rated 600 volts of same material as conductor metal.
3. Uninsulated Crimp Connectors and Terminators:
   a. Suitable for use with 75 degrees C wire at full NFPA 70, 75 degrees C ampacity.
   b. Manufacturers and Products:
      1) Thomas & Betts; Color-Keyed.
      2) Burndy; Hydent.
      3) ILSCO.
4. Uninsulated, Bolted, Two-Way Connectors and Terminators:
   a. Manufacturers and Products:
      1) Thomas & Betts; Locktite.
      2) Burndy; Quiklug.
      3) ILSCO.

E. Cable Ties:

1. Nylon, adjustable, self-locking, and reusable.
2. Manufacturer and Product: Thomas & Betts; TY-RAP.

F. Heat Shrinkable Insulation:

1. Thermally stabilized cross-linked polyolefin.
2. Single wall for insulation and strain relief.
3. Dual Wall, adhesive sealant lined, for sealing and corrosion resistance.
4. Manufacturers and Products:
   a. Thomas & Betts; SHRINK-KON.
   b. Raychem; RNF-100 and ES-2000.

2.06 PULLING COMPOUND

A. Nontoxic, noncorrosive, noncombustible, nonflammable, water-based lubricant; UL listed.

B. Suitable for rubber, neoprene, PVC, polyethylene, hypalon, CPE, and lead-covered wire and cable.

C. Approved for intended use by cable manufacturer.

D. Suitable for zinc-coated steel, aluminum, PVC, bituminized fiber, and fiberglass raceways.

E. Manufacturers:

1. Ideal Co.
2. Polywater, Inc.
3. Cable Grip Co.

2.07 WARNING TAPE

A. As specified in Section 26 05 33, Raceway and Boxes.

2.08 SOURCE QUALITY CONTROL

A. Conductors 600 Volts and Below: Test in accordance with UL 44 and UL 854.

PART 3 EXECUTION

3.01 GENERAL

A. Conductor installation shall be in accordance with manufacturer's recommendations.

B. Conductor and cable sizing shown is based on copper conductors, unless noted otherwise.

C. Do not exceed cable manufacturer's recommendations for maximum pulling tensions and minimum bending radii.

D. Terminate conductors and cables, unless otherwise indicated.

E. Tighten screws and terminal bolts in accordance with UL 486A-486B for copper conductors.

F. Cable Lugs: Provide with correct number of holes, bolt size, and center-to-center spacing as required by equipment terminals.

G. 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 18 inches on center.

H. Ream, remove burrs, and clear interior of installed conduit before pulling wires or cables.

I. Concrete-Encased Raceway Installation: Prior to installation of conductors, pull through each raceway a mandrel approximately 1/4 inch smaller than raceway inside diameter.

J. Cable Tray Installation:

1. Install wire and cable parallel and straight in tray.
2. Bundle, in groups, wire and cable of same voltage having a common routing and destination; use cable ties, at maximum intervals of 8 feet.
3. Clamp cable bundles prior to making end termination connections.
4. Separate cables of different voltage rating in same cable tray with barriers.
5. Fasten wires, cables, and bundles to tray with nylon cable straps at the following maximum intervals:
   a. Horizontal Runs: 20 feet.
   b. Vertical Runs: 5 feet.

3.02 POWER CONDUCTOR COLOR CODING

A. Conductors 600 Volts and Below:

1. 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 area 1-1/2 inches to 2 inches wide.
2. 8 AWG and Smaller: Provide colored conductors.
3. Colors:

System	Conductor	Color
All Systems	Equipment Grounding	Green
240/120 Volts, Single-Phase, Three-Wire	Grounded Neutral One Hot Leg Other Hot Leg	White Black Red
208Y/120 Volts, Three-Phase, Four-Wire	Grounded Neutral Phase A Phase B Phase C	White Black Red Blue
240/120 Volts, Three-Phase, Four-Wire, Delta, Center Tap, Ground on Single-Phase	Grounded Neutral Phase A High (wild) Leg Phase C	White Black Orange Blue
480Y/277 Volts, Three-Phase, Four-Wire	Grounded Neutral Phase A Phase B Phase C	White Brown Orange Yellow
Note: Phase A, B, C implies direction of positive phase rotation.		

4. Tracer: Outer covering of white with identifiable colored strip, other than green, in accordance with NFPA 70.

3.03 CIRCUIT IDENTIFICATION

A. Identify power, instrumentation, and control conductor circuits at each termination, and in accessible locations such as manholes, handholes, panels, switchboards, motor control centers, pull boxes, and terminal boxes. Where conductors are bundled together and pulled straight through a box and in manholes/handholes tag each bundle with a TO/FROM label in lieu of individually labeling each wire. Where wires are spliced or tapped provide an individual label for each wire, except for neutrals (which are identified by color coding).

B. Label analog cables with a marker that describes INSTRUMENT TAG/ DESTINATION PANEL. Label each conductor in the cable with INSTRUMENT TERMINAL NUMBER/DESTINATION TERMINAL NUMBER.

C. Label digital communication cables and fiber optic cables with a TO/FROM marker.

D. Label the conductors of discrete signals from instruments and devices with the signal's LOOP NUMBER/DESTINATION TERMINAL NUMBER.

E. Label the conductors of power feeders and branch circuits with the equipment designation of the source equipment plus a suffix that includes the bucket number, the compartment number, or the panelboard circuit identifier.

F. Method:

1. Conductors 3 AWG and Smaller: Identify with sleeves or heat bond markers.
2. Cables and Conductors 2 AWG and Larger:
   a. Identify with marker plates or tie-on cable marker tags.
   b. Attach with nylon tie cord.
3. Taped-on markers or tags relying on adhesives not permitted.

3.04 CONDUCTORS 600 VOLTS AND BELOW

A. Install 10 AWG or 12 AWG conductors for branch circuit power wiring in lighting and receptacle circuits.

B. Do not splice incoming service conductors and branch power distribution conductors 6 AWG and larger, unless specifically indicated or approved by Engineer.

C. Connections and Terminations:

1. Install wire nuts only on solid conductors. Wire nuts are not allowed on stranded conductors.
2. Install nylon self-insulated crimp connectors and terminators for instrumentation and control, circuit conductors.
3. Install self-insulated, set screw wire connectors for two-way connection of power circuit conductors 12 AWG and smaller.
4. Install uninsulated crimp connectors and terminators for instrumentation, control, and power circuit conductors 4 AWG through 2/0 AWG.
5. Install uninsulated, bolted, two-way connectors and terminators for power circuit conductors 3/0 AWG and larger.

6. Install uninsulated terminators bolted together on motor circuit conductors 10 AWG and larger.
7. Place no more than one conductor in any single-barrel pressure connection.
8. Install crimp connectors with tools approved by connector manufacturer.
9. Install terminals and connectors acceptable for type of material used.
10. Compression Lugs:
    a. Attach with a tool specifically designed for purpose. Tool shall provide complete, controlled crimp and shall not release until crimp is complete.
    b. Do not use plier type crimpers.

D. Do not use soldered mechanical joints.

E. Splices and Terminations:

1. Insulate uninsulated connections.
2. Indoors: Use general purpose, flame retardant tape or single wall heat shrink.
3. Outdoors, Dry Locations: Use flame retardant, cold- and weather-resistant tape or single wall heat shrink.
4. Below Grade and Wet or Damp Locations: Use dual wall heat shrink.

F. Cap spare conductors with UL listed end caps.

G. Cabinets, Panels, and Motor Control Centers:

1. Remove surplus wire, bridle and secure.
2. Where conductors pass through openings or over edges in sheet metal, remove burrs, chamfer edges, and install bushings and protective strips of insulating material to protect the conductors.

H. Control and Instrumentation Wiring:

1. Where terminals provided will accept such lugs, terminate control and instrumentation wiring, except solid thermocouple leads, with insulated, locking-fork compression lugs.
2. Terminate with methods consistent with terminals provided, and in accordance with terminal manufacturer’s instructions.
3. Locate splices in readily accessible cabinets or junction boxes using terminal strips.

4. Where connections of cables installed under this section are to be made under Section 40 90 00, Instrumentation and Control for Process Systems, leave pigtails of adequate length for bundled connections.
5. Cable Protection:
    a. Maintain integrity of shielding of instrumentation cables.
    b. Ensure grounds do not occur because of damage to jacket over shield.

I. Extra Conductor Length: For conductors to be connected by others, install minimum 6 feet of extra conductor in freestanding panels and minimum 2 feet in other assemblies.

END OF SECTION

SECTION 26 05 26
GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 REFERENCES

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

1. Institute of Electrical and Electronics Engineers (IEEE): C2, National Electrical Safety Code (NESC).
2. National Fire Protection Association (NFPA): 70, National Electrical Code. (NEC).

1.02 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
   a. Product data for the following:
      1) Exothermic weld connectors.
      2) Mechanical connectors.
      3) Compression connectors.
      4) Specialty tools.

1.03 QUALITY ASSURANCE

A. 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.

PART 2 PRODUCTS

2.01 GROUND ROD

A. Material: Copper-clad.

B. Diameter: Minimum 5/8 inch.

C. Length: 10 feet.

2.02 GROUND CONDUCTORS

A. As specified in Section 26 05 05, Conductors.

2.03 CONNECTORS

A. Exothermic Weld Type:

1. Outdoor Weld: Suitable for exposure to elements or direct burial.
2. Indoor Weld: Utilize low-smoke, low-emission process.
3. Manufacturers:
   a. Erico Products, Inc.; Cadweld and Cadweld Exolon.
   b. Thermoweld.

B. Compression Type:

1. Compress-deforming type; wrought copper extrusion material.
2. Single indentation for conductors 6 AWG and smaller.
3. Double indentation with extended barrel for conductors 4 AWG and larger.
4. Barrels prefilled with oxide-inhibiting and antiseizing compound and sealed.
5. Manufacturers:
   a. Burndy Corp.; Hyground irreversible compression.
   b. Thomas and Betts Co.
   c. ILSCO.

C. Mechanical Type: Split-bolt, saddle, or cone screw type; copper alloy material.

1. Manufacturers:
   a. Burndy Corp.
   b. Thomas and Betts Co.

2.04 GROUNDING WELLS

A. Ground rod box complete with cast iron riser ring and traffic cover marked GROUND ROD.

B. Manufacturers and Products:

1. Christy Co.; No. G5.
2. Lightning and Grounding Systems, Inc.; I-R Series.

PART 3 EXECUTION

3.01 GENERAL

A. Grounding shall be in compliance with NFPA 70 and IEEE C2.

B. Ground electrical service neutral at service entrance equipment with grounding electrode conductor to grounding electrode system.

C. Ground each separately derived system neutral with common grounding electrode conductor to grounding electrode system.

D. Bond together all grounding electrodes that are present at each building or structure served to form one common grounding electrode system.

E. 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.

F. Shielded Power Cables: Ground shields at each splice or termination in accordance with recommendations of splice or termination manufacturer.

G. 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.

3.02 WIRE CONNECTIONS

A. Ground Conductors: Install in conduit containing power conductors and control circuits above 50 volts.

B. Nonmetallic Raceways and Flexible Tubing: Install equipment grounding conductor connected at both ends to noncurrent-carrying grounding bus.

C. Connect ground conductors to raceway grounding bushings.

D. Extend and connect ground conductors to ground bus in all equipment containing a ground bus.

E. Connect enclosure of equipment containing ground bus to that bus.

F. Bolt connections to equipment ground bus.

G. Bond grounding conductors to metallic enclosures at each end, and to intermediate metallic enclosures.

H. Junction Boxes: Furnish materials and connect to equipment grounding system with grounding clips mounted directly on box, or with 3/8-inch machine screws.

I. Metallic Equipment Enclosures: Use furnished ground lug; if none furnished, tap equipment housing and install solderless terminal connected to box with machine screw. For circuits greater than 20 amps use minimum 5/16-inch diameter bolt.

3.03 MOTOR GROUNDING

A. Extend equipment ground bus via grounding conductor installed in motor feeder raceway; connect to motor frame.

B. Nonmetallic Raceways and Flexible Tubing: Install an equipment grounding conductor connected at both ends to noncurrent-carrying grounding bus.

C. Motors Less Than 10 hp: Use furnished ground lug in motor connection box; if none furnished, provide compression, spade-type terminal connected to conduit box mounting screw.

D. Motors 10 hp and Above: Use furnished ground lug in motor connection box; if none furnished, tap motor frame or equipment housing; furnish compression, one-hole, lug type terminal connected with minimum 5/16-inch brass threaded stud with bolt and washer.

E. Circuits 20 Amps or Above: Tap motor frame or equipment housing; install solderless terminal with minimum 5/16-inch diameter bolt.

3.04 GROUND RODS

A. Install full length with conductor connection at upper end.

B. Install with connection point below finished grade, unless otherwise shown.

C. Space multiple ground rods by one rod length.

D. Install to 8 feet below local frost depth.

3.05 GROUNDING WELLS

A. Install for ground rods located inside buildings, asphalt and paved areas, and where shown on Drawings.

B. Install riser ring and cover flush with surface.

C. Place 6 inches of crushed rock in bottom of each well.

3.06 CONNECTIONS

A. General:

1. Abovegrade Connections: Install exothermic weld, mechanical, or compression-type connectors; or brazing.
2. Belowgrade Connections: Install exothermic weld or compression type connectors.
3. Remove paint, dirt, or other surface coverings at connection points to allow good metal-to-metal contact.
4. Notify Engineer prior to backfilling ground connections.

B. Exothermic Weld Type:

1. Wire brush or file contact point to bare metal surface.
2. Use welding cartridges and molds in accordance with manufacturer's recommendations.
3. Avoid using badly worn molds.
4. Mold to be completely filled with metal when making welds.
5. After completed welds have cooled, brush slag from weld area and thoroughly clean joint.

C. Compression Type:

1. Install in accordance with connector manufacturer's recommendations.
2. Install connectors of proper size for grounding conductors and ground rods specified.
3. Install using connector manufacturer's compression tool having proper sized dies and operate per manufacturer's instructions.

D. Mechanical Type:

1. Apply homogeneous blend of colloidal copper and rust and corrosion inhibitor before making connection.
2. Install in accordance with connector manufacturer's recommendations.
3. Do not conceal mechanical connections.

3.07 METAL STRUCTURE GROUNDING

A. Bond metal sheathing and exposed metal vertical structural elements to grounding system.

B. Bond electrical equipment supported by metal platforms to the platforms.

C. Provide electrical contact between metal frames and railings supporting pushbutton stations, receptacles, and instrument cabinets, and raceways carrying circuits to these devices.

3.08 MANHOLE AND HANDHOLE GROUNDING

A. Install one ground rod inside each manhole and handhole larger than 24-inch by 24-inch inside dimensions.

B. Ground Rod Floor Protrusion: 4 inches to 6 inches above floor.

C. Make connections of grounding conductors fully visible and accessible.

D. Connect all noncurrent-carrying metal parts, and any metallic raceway grounding bushings to ground rod with 6 AWG copper conductor.

3.09 TRANSFORMER GROUNDING

A. Bond neutrals of transformers within buildings to system ground network, and to any additional indicated grounding electrodes.

B. Bond neutrals of pad-mounted transformers to locally driven ground rods and buried ground wire encircling transformer and system ground network.

3.10 LIGHTNING PROTECTION SYSTEMS

A. Bond lightning protection system ground terminals to building or structure grounding electrode system.

3.11 SURGE PROTECTION EQUIPMENT GROUNDING

A. Connect surge arrestor ground terminals to equipment ground bus.

END OF SECTION

SECTION 26 05 33
RACEWAY AND BOXES

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): HB, Standard Specifications for Highway Bridges.
2. ASTM International (ASTM):
   a. A123/123M, Standard Specification for Zinc (Hot-Dipped Galvanized) Coatings on Iron and Steel Products.
   b. A167, Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.
   c. A240/A240M, Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
   d. C857, Standard Practice for Minimum Structural Design Loading for Underground Precast Concrete Utility Structures.
   e. D149, Standard Test Method for Dielectric Breakdown Voltage and Dielectric Strength of Solid Electrical Insulating Materials at Commercial Power Frequencies.
3. Telecommunications Industry Association (TIA): 569B, Commercial Building Standard for Telecommunications Pathways and Spaces.
4. National Electrical Contractor's Association, Inc. (NECA): Installation standards.
5. National Electrical Manufacturers Association (NEMA):
   a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
   b. C80.1, Electrical Rigid Steel Conduit (ERSC).
   c. C80.3, Steel Electrical Metallic Tubing (EMT).
   d. C80.5, Electrical Rigid Aluminum Conduit (ERAC).
   e. C80.6, Electrical Intermediate Metal Conduit (EIMC).
   f. RN 1, Polyvinyl Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit.
   g. TC 2, Electrical Polyvinyl Chloride (PVC) Conduit.
   h. TC 3, Polyvinyl Chloride (PVC) Fittings for Use with Rigid PVC Conduit and Tubing.
   i. TC 6, Polyvinyl Chloride (PVC) Plastic Utilities Duct for Underground Installation.
   j. TC 14, Reinforced Thermosetting Resin Conduit (RTRC) and Fittings.
   k. VE 1, Metallic Cable Tray Systems.

6. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC).
7. Underwriters Laboratories Inc. (UL):
    a. 1, Standard for Safety for Flexible Metal Conduit.
    b. 5, Standard for Safety for Surface Metal Raceways and Fittings.
    c. 6, Standard for Safety for Electrical Rigid Metal Conduit – Steel.
    d. 6A, Standard for Safety for Electrical Rigid Metal Conduit – Aluminum, Red Brass and Stainless.
    e. 360, Standard for Safety for Liquid-Tight Flexible Steel Conduit.
    f. 514B, Standard for Safety for Conduit, Tubing, and Cable Fittings.
    g. 651, Standard for Safety for Schedule 40 and 80 Rigid PVC Conduit and Fittings.
    h. 651A, Standard for Safety for Type EB and A Rigid PVC Conduit and HDPE Conduit.
    i. 797, Standard for Safety for Electrical Metallic Tubing – Steel.
    j. 870, Standard for Safety for Wireways, Auxiliary Gutters, and Associated Fittings.
    k. 1242, Standard for Safety for Electrical Intermediate Metal Conduit – Steel.
    l. 1660, Standard for Safety for Liquid-Tight Flexible Nonmetallic Conduit.
    m. 1684, Standard for Safety for Reinforced Thermosetting Resin Conduit (RTRC) and Fittings.
    n. 2024, Standard for Safety for Optical Fiber and Communication Cable Raceway.

1.02 SUBMITTALS

A. Action Submittals:

1. Manufacturer’s Literature:
    a. Device boxes for use in hazardous areas.
    b. Junction and pull boxes used at or below grade.
    c. Large junction and pull boxes.
    d. Terminal junction boxes.
2. Precast Manholes and Handholes:
    a. Dimensional drawings and descriptive literature.
    b. Traffic loading calculations.
    c. Accessory information.
3. Cable Tray Systems:
    a. Dimensional drawings, calculations, and descriptive information.
    b. NEMA load/span designation and how it was selected.
    c. Support span length and pounds-per-foot actual and future cable loading at locations, with safety factor used.

d. Location and magnitude of maximum simple beam deflection of tray for loading specified.
e. Layout drawings and list of accessories being provided.

4. Seismic anchorage and bracing drawings and cut sheets, as required by Section 01 88 15, Anchorage and Bracing.

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.

1.03 QUALITY ASSURANCE

A. 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 scope of standards published by Underwriters Laboratories, Inc. shall conform to those standards and shall have an applied UL listing mark.

PART 2 PRODUCTS

2.01 CONDUIT AND TUBING

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. Intermediate Metal Conduit (IMC):

1. Meet requirements of NEMA C80.6 and UL 1242.
2. Material: Hot-dip galvanized with chromated and lacquered protective layer.

C. 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.
3. Furnish without factory-formed bell.

D. PVC-Coated Rigid Galvanized Steel Conduit:

1. Meet requirements of NEMA RN 1 and ETL.
2. Material:
   a. Meet requirements of NEMA C80.1 and UL 6.
   b. Exterior Finish: PVC coating, 40-mil nominal thickness; bond to metal shall have tensile strength greater than PVC.
   c. Interior finish: Urethane coating, 2-mil nominal thickness.
3. Threads: Hot-dipped galvanized and factory coated with urethane.
4. Bendable without damage to interior or exterior coating.

E. Flexible Metal, Liquid-Tight Conduit:

1. UL 360 listed for 105 degrees C insulated conductors.
2. Material: Galvanized steel with extruded PVC jacket.

F. Flexible Metal, Nonliquid-Tight Conduit:

1. Meet requirements of UL 1.
2. Material: Galvanized steel.

G. Flexible, Nonmetallic, Liquid-Tight Conduit:

1. Material: PVC core with fused flexible PVC jacket.
2. UL 1660 listed for:
   a. Dry Conditions: 80 degrees C insulated conductors.
   b. Wet Conditions: 60 degrees C insulated conductors.
3. Manufacturers and Products:
   a. Carlon; Carflex or X-Flex.
   b. T & B; Xtraflex LTC or EFC.

2.02 FITTINGS

A. Rigid Galvanized Steel and Intermediate Metal Conduit:

1. General:
   a. Meet requirements of UL 514B.
   b. Type: Threaded, galvanized. Set screw and threadless compression fittings not permitted.
2. Bushing:
   a. Material: Malleable iron with integral insulated throat, rated for 150 degrees C.
   b. Manufacturers and Products:
      1) Appleton; Series BU-I.
      2) O-Z/Gedney; Type HB.

3. Grounding Bushing:
   a. Material: Malleable iron with integral insulated throat rated for 150 degrees C, with solderless lugs.
   b. Manufacturers and Products:
      1) Appleton; Series GIB.
      2) O-Z/Gedney; Type HBLG.
4. Conduit Hub:
   a. Material: Malleable iron with insulated throat with bonding screw.
   b. UL listed for use in wet locations.
   c. Manufacturers and Products:
      1) Appleton, Series HUB-B.
      2) O-Z/Gedney; Series CH.
      3) Meyers; ST Series.
5. Conduit Bodies:
   a. Sized as required by NFPA 70.
   b. Manufacturers and Products (For Normal Conditions):
      1) Appleton; Form 35 threaded unilets.
      2) Crouse-Hinds; Form 7 or Form 8 threaded condulets.
      3) Killark; Series O electrolets.
      4) Thomas & Betts; Form 7 or Form 8.
   c. Manufacturers (For Hazardous Locations):
      1) Appleton.
      2) Crouse-Hinds.
      3) Killark.
6. Couplings: As supplied by conduit manufacturer.
7. Unions:
   a. Concrete tight, hot-dip galvanized malleable iron.
   b. Manufacturers and Products:
      1) Appleton; Series SCC bolt-on coupling or Series EC three-piece union.
      2) O-Z/Gedney; Type SSP split coupling or Type 4 Series, three-piece coupling.
8. Conduit Sealing Fitting:
   a. Manufacturers and Products:
      1) Appleton; Type EYF, EYM, or ESU.
      2) Crouse-Hinds; Type EYS or EZS.
      3) Killark; Type EY or Type EYS.
9. Drain Seal:
   a. Manufacturers and Products:
      1) Appleton; Type EYD.
      2) Crouse-Hinds; Type EYD or Type EZD.
10. Drain/Breather Fitting:
    a. Manufacturers and Products:
       1) Appleton; Type ECDB.
       2) Crouse-Hinds; ECD.

11. Expansion Fitting:
    a. Manufacturers and Products:
        1) Deflection/Expansion Movement:
            a) Appleton; Type DF.
            b) Crouse-Hinds; Type XD.
        2) Expansion Movement Only:
            a) Appleton; Type XJ.
            b) Crouse-Hinds; Type XJ.
            c) Thomas & Betts; XJG-TP.
12. Cable Sealing Fitting:
    a. To form watertight nonslip cord or cable connection to conduit.
    b. For Conductors with OD of 1/2 inch or Less: Neoprene bushing at connector entry.
    c. Manufacturers and Products:
        1) Appleton; CG-S.
        2) Crouse-Hinds; CGBS.

B. PVC Conduit and Tubing:

1. Meet requirements of NEMA TC 3.
2. Type: PVC, slip-on.

C. PVC-Coated Rigid Galvanized Steel Conduit:

1. Meet requirements of UL 514B.
2. Fittings: Rigid galvanized steel type, PVC coated by conduit manufacturer.
3. Conduit Bodies: Cast metal hot-dipped galvanized or urethane finish. Cover shall be of same material as conduit body. PVC coated by conduit manufacturer.
4. Finish: 40-mil PVC exterior, 2-mil urethane interior.
5. Overlapping pressure-sealing sleeves.
6. Conduit Hangers, Attachments, and Accessories: PVC-coated.
7. Manufacturers:
    a. Robroy Industries.
    b. Ocal.
8. Expansion Fitting:
    a. Manufacturer and Product: Ocal; OCAL-BLUE XJG.

D. Flexible Metal, Liquid-Tight Conduit:

1. Metal insulated throat connectors with integral nylon or plastic bushing rated for 105 degrees C.
2. Insulated throat and sealing O-rings.
3. Manufacturers and Products:
    a. Thomas & Betts; Series 5331.
    b. O-Z/Gedney; Series 4Q.

E. Flexible Metal, Nonliquid-Tight Conduit:

1. Meet requirements of UL 514B.
2. Body: Galvanized steel or malleable iron.
3. Throat: Nylon insulated.
4. 1-1/4-Inch Conduit and Smaller: One screw body.
5. 1-1/2-Inch Conduit and Larger: Two screw body.
6. Manufacturer and Product: Appleton; Series 7400.

F. Flexible, Nonmetallic, Liquid-Tight Conduit:

1. Meet requirements of UL 514B.
2. Type: High strength plastic body, complete with lock nut, O-ring, threaded ferrule, sealing ring, and compression nut.
3. Body/compression nut (gland) design to ensure high mechanical pullout strength and watertight seal.
4. Manufacturers and Products:
   a. Carlon; Type LT.
   b. O-Z/Gedney; Type 4Q-P.
   c. Thomas & Betts; Series 6300.

G. Watertight Entrance Seal Device:

1. New Construction:
   a. Material: Oversized sleeve, malleable iron body with sealing ring, pressure ring, grommet seal, and pressure clamp.
   b. Manufacturer and Product: O-Z/Gedney; Type FSK or Type WSK, as required.
2. Cored-Hole Application:
   a. Material: Assembled dual pressure disks, neoprene sealing ring, and membrane clamp.
   b. Manufacturer and Product: O-Z/Gedney; Series CSM.

2.03 OUTLET AND DEVICE BOXES

A. Sheet Steel: One-piece drawn type, zinc-plated or cadmium-plated.

B. Cast Metal:

1. Box: Malleable iron or cast ferrous metal.
2. Cover: Gasketed, weatherproof, malleable iron or 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 Type FD.
    b. Appleton; Type FS or Type FD.
    c. Killark.
6. Manufacturers and Products, Hazardous Locations:
    a. Crouse-Hinds; Type GUA or Type EAJ.
    b. Appleton; Type GR.

C. PVC-Coated Cast Metal:

1. Type: One-piece.
2. Material: Malleable iron, cast ferrous metal, or cast aluminum.
3. Coating:
    a. Exterior Surfaces: 40-mil PVC.
    b. Interior Surfaces: 2-mil urethane.
4. Manufacturers:
    a. Robroy Industries.
    b. Ocal.

D. Nonmetallic:

1. Box: PVC.
2. Cover: PVC, weatherproof, with stainless steel screws.
3. Manufacturer and Product: Carlon; Type FS or Type FD, with Type E98 or Type E96 covers.

2.04 JUNCTION AND PULL BOXES

A. Outlet Box 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 Fittings.

C. Large Sheet Steel Box:

1. NEMA 250, Type 1.
2. Box: Code-gauge, galvanized steel.
3. Cover: Full access, screw type.
4. Machine Screws: Corrosion-resistant.

D. Large Stainless Steel Box:

1. NEMA 250 Type 4X.
2. Box: 14-gauge, ASTM A240/A240M, Type 304 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.
    c. Wiegman.

E. Large Nonmetallic Box:

1. NEMA 250 Type 4X.
2. Box: High-impact, fiberglass-reinforced polyester or engineered thermoplastic, with stability to high heat.
3. Cover: Hinged with clamps.
4. Hardware and Machine Screws: ASTM A167, Type 316 stainless steel.
5. Conduit hubs and mounting lugs.
6. Manufacturers and Products:
    a. Crouse-Hinds; Type NJB.
    b. Carlon; Series N, C, or H.
    c. Robroy Industries.

F. 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 inches by 17 inches, minimum.
5. Manufacturers and Products:
    a. Utility Vault Co.; Series 36-1017.
    b. Christy, Concrete Products, Inc.; N9.
    c. Quazite; “PG” Style.

G. Concrete Box, Traffic Areas:

1. Box: Reinforced, cast concrete with extension and bottom slab.
2. Cover: Steel checked plate; H/20 loading with screw down.
3. Cover Marking: ELECTRICAL, TELEPHONE, or as shown.
4. Manufacturers and Products:
    a. Christy, Concrete Products, Inc.; B1017BOX.
    b. Utility Vault Co.; 3030 SB.

2.05 TERMINAL JUNCTION BOX

A. Cover: Hinged, unless otherwise shown.

B. Interior Finish: Paint with white enamel or lacquer.

C. Terminal Blocks:

1. Separate connection point for each conductor entering or leaving box.
2. Spare Terminal Points: 25 percent, minimum.

2.06 PRECAST MANHOLES AND HANDHOLES

A. Concrete Strength: Minimum, 3,000 psi compressive, in 28 days.

B. Loading: AASHTO, H-20 in accordance with ASTM C857.

C. Access: Provide cast concrete 6- or 12-inch risers and access hole adapters between top of manhole and finished grade at required elevations.

D. Drainage:

1. Slope floors toward drain points, leaving no pockets or other nondraining areas.
2. Provide drainage outlet or sump at low point of floor constructed with a heavy, cast iron, slotted or perforated hinged cover, and a minimum 4-inch outlet and outlet pipe.

E. Raceway Entrances:

1. Provide on all four sides.
2. Provide knockout panels or precast individual raceway openings.
3. At entrances where raceways are to be installed by others, provide minimum 12-inch-high by 24-inch-wide knockout panels for future raceway installation.

F. Embedded Pulling Iron:

1. Material: 3/4-inch-diameter stock, fastened to overall steel reinforcement before concrete is placed.
2. Location:
   a. Wall: Opposite each raceway entrance and knockout panel for future raceway entrance.
   b. Floor: Centered below manhole or handhole cover.

G. Cable Racks:

1. Arms and Insulators: Adjustable, of sufficient number to accommodate cables for each raceway entering or leaving manhole, including spares.

2. Wall Attachment:
    a. Adjustable inserts in concrete walls. Bolts or embedded studs not permitted.
    b. Insert Spacing: Maximum 3 feet on center for inside perimeter of manhole.
    c. Arrange in order that spare raceway ends are clear for future cable installation.

H. Manhole Frames and Covers:

1. Material: Machined cast iron.
2. Diameter: 32 inch.
3. Cover Type: Indented, solid top design, with two drop handles each.
4. Cover Loading: AASHTO H-20.
5. Cover Designation: Cast, on upper side, in integral letters, minimum 2 inches in height, appropriate titles:
    a. Above 600 Volts: ELECTRIC HV.
    b. 600 Volts and Below: ELECTRIC LV.
    c. TELEPHONE.

I. Handhole Frames and Covers:

1. Material: Steel, hot-dipped galvanized.
2. Cover Type: Solid, hinged, torsion spring, of checkered nonskid design.
3. Cover Loading: AASHTO H-20.
4. Cover Designation: Burn by welder, on upper side in integral letters, minimum 2 inches in height, appropriate titles:
    a. 600 Volts and Below: ELECTRIC LV.
    b. TELEPHONE.

J. Hardware: Steel, hot-dip galvanized.

K. Furnish knockout for ground rod in each handhole and manhole.

L. Manufacturers:

1. Utility Vault Co.
2. Penn-Cast Products, Inc.
3. Concrete Conduit Co.
4. Associated Concrete Products, Inc.
5. Pipe, Inc.

2.07 ACCESSORIES

A. Duct Bank Spacers:

1. Modular Type:
   a. Nonmetallic, interlocking, for multiple conduit sizes.
   b. Suitable for all types of conduit.
   c. Manufacturers:
      1) Underground Device, Inc.
      2) Carlon.
2. Template Type:
   a. Nonmetallic, custom made one-piece spacers.
   b. Suitable for all types of conduit.
   c. Material: HDPE or polypropylene, 1/2-inch minimum thickness.
   d. Conduit openings cut 1 inch larger than conduit outside diameter.
   e. Additional openings for stake-down, rebar, and concrete flow through as required.
   f. Manufacturer and Product: SP Products; Quik Duct.

B. Identification Devices:

1. Raceway Tags:
   a. Material: Permanent, 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 6 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.
   f. Manufacturers and Products:
      1) Panduit; Type HTDU.
      2) Reef Industries; Terra Tape.
3. Buried Raceway Marker:
   a. Material: Sheet bronze, consisting of double-ended arrows, straight for straight runs and bent at locations where runs change direction.
   b. Designation: Engrave to depth of 3/32 inch; ELECTRIC CABLES, in letters 1/4-inch high.
   c. Minimum Dimension: 1/4 inch thick, 10 inches long, and 3/4 inch wide.

C. Heat Shrinkable Tubing:

1. Material: Heat-shrinkable, cross-linked polyolefin.
2. Semi-flexible with meltable adhesive inner liner.
3. Color: Black.
4. Manufacturers:
   a. Raychem.
   b. 3M.

D. Wraparound Duct Band:

1. Material: Heat-shrinkable, cross-linked polyolefin, precoated with hot-melt adhesive.
2. Width: 50 mm minimum.
3. Manufacturer and Product: Raychem; Type TWDB.

PART 3 EXECUTION

3.01 GENERAL

A. Conduit and tubing sizes shown are based on use of copper conductors. Reference Section 26 05 05, Conductors, concerning conduit sizing for aluminum conductors.

B. Comply with NECA Installation Standards.

C. Crushed or deformed raceways not permitted.

D. Maintain raceway entirely free of obstructions and moisture.

E. Immediately after installation, plug or cap raceway ends with watertight and dust-tight seals until time for pulling in conductors.

F. Sealing Fittings: Provide drain seal in vertical raceways where condensate may collect above sealing fitting.

G. Avoid moisture traps where possible. When unavoidable in exposed conduit runs, provide junction box and drain fitting at conduit low point.

H. Group raceways installed in same area.

I. Proximity to Heated Piping: Install raceways minimum 12 inches from parallel runs.

J. Follow structural surface contours when installing exposed raceways. Avoid obstruction of passageways.

K. Run exposed raceways parallel or perpendicular to walls, structural members, or intersections of vertical planes.

L. Block Walls: Do not install raceways in same horizontal course or vertical cell with reinforcing steel.

M. Install watertight fittings in outdoor, underground, or wet locations.

N. Paint threads and cut ends, before assembly of fittings, galvanized conduit, PVC-coated galvanized conduit, or IMC installed in exposed or damp locations with zinc-rich paint or liquid galvanizing compound.

O. Metal conduit shall be reamed, burrs removed, and cleaned before installation of conductors, wires, or cables.

P. Do not install raceways in concrete equipment pads, foundations, or beams without Engineer approval.

Q. Horizontal raceways installed under floor slabs shall lie completely under slab, with no part embedded within slab.

R. Install concealed, embedded, and buried raceways so that they emerge at right angles to surface and have no curved portion exposed.

S. Install conduits for fiber optic cables, telephone cables, and Category 6 data cables in strict conformance with the requirements of TIA 569B.

3.02 REUSE OF EXISTING CONDUITS

A. Where Drawings indicate existing conduits may be reused, they may be reused only where they meet the following criteria.

1. Conduit is in useable condition with no deformation, corrosion, or damage to exterior surface.
2. Conduit is sized per the NEC.
3. Conduit is of the type specified in Contract Documents.
4. Conduit is supported as specified in Contract Documents.

B. Conduit shall be reamed with wire brush, then with a mandrel approximately 1/4 inch smaller than raceway inside diameter then cleaned prior to pulling new conductors.

3.03 INSTALLATION IN CAST-IN-PLACE STRUCTURAL CONCRETE

A. Minimum Cover: 2 inches, including fittings.

B. Conduit placement shall not require changes in reinforcing steel location or configuration.

C. Provide nonmetallic support during placement of concrete to ensure raceways remain in position.

D. Conduit larger than 1 inch shall not be embedded in concrete slabs, walls, foundations, columns, or beams unless approved by Engineer.

E. Slabs and Walls (Requires Engineer Approval):

1. Trade size of conduit not to exceed one-fourth of slab or wall thickness.
2. Install within middle two-fourths of slab or wall.
3. Separate conduit less than 2-inch trade size by a minimum ten times conduit trade size, center-to-center, unless otherwise shown.
4. Separate conduit 2-inch and greater trade size by a minimum eight times conduit trade size, center-to-center, unless otherwise shown.
5. Cross conduit at an angle greater than 45 degrees, with minimum separation of 1 inch.
6. Separate conduit by a minimum six times the outside dimension of expansion/deflection fittings at expansion joints.
7. Conduit shall not be installed below the maximum water surface elevation in walls of water holding structures.

F. Columns and Beams (Requires Engineer Approval):

1. Trade size of conduit not to exceed one-fourth of beam thickness.
2. Conduit cross-sectional area not to exceed 4 percent of beam or column cross section.

3.04 CONDUIT APPLICATION

A. Diameter: Minimum 3/4 inch.

B. Exterior, Exposed: PVC-coated rigid galvanized steel.

C. Interior, Exposed, Non-Corrosive: Rigid galvanized steel.

D. Aboveground, Embedded in Concrete Walls, Ceilings, or Floors: Intermediate metal or PVC Schedule 40.

E. Direct Earth Burial: PVC Schedule 40 for ac circuits, PVC-Coated Rigid Galvanized Steel for dc circuits.

F. Concrete-Encased Ductbank: PVC Schedule 40 for ac circuits, PVC-Coated Rigid Galvanized Steel for dc circuits.

G. Under Slabs-On-Grade: PVC Schedule 40 for ac circuits, PVC-Coated Rigid Galvanized Steel for dc circuits.

H. Transition from Underground or Concrete Embedded to Exposed: PVC-coated rigid steel conduit.

I. Under Equipment Mounting Pads: PVC-coated rigid steel conduit.

J. Corrosive Areas: PVC-coated rigid galvanized steel.

3.05 FLEXIBLE CONNECTIONS

A. For motors, wall or ceiling mounted fans and unit heaters, dry type transformers, electrically operated valves, instrumentation, and other locations approved by Engineer where flexible connection is required to minimize vibration:

1. Conduit Size 4 Inches or Less: Flexible, liquid-tight conduit.
2. Conduit Size Over 4 Inches: Nonflexible.
3. Wet or Corrosive Areas: Flexible, nonmetallic or flexible metal liquid-tight.
4. Dry Areas: Flexible, metallic liquid-tight.

B. Suspended Lighting Fixtures in Dry Areas: Flexible steel, nonliquid-tight conduit.

C. Outdoor Areas, Process Areas Exposed to Moisture, and Areas Required to be Oiltight and Dust-Tight: Flexible metal, liquid-tight conduit.

D. Flexible Conduit Length: 18 inches minimum, 60 inches maximum; sufficient to allow movement or adjustment of equipment.

3.06 PENETRATIONS

A. Make at right angles, unless otherwise shown.

B. Notching or penetration of structural members, including footings and beams, not permitted.

C. Fire-Rated Walls, Floors, or Ceilings: Firestop openings around penetrations to maintain fire-resistance rating as specified in Section 26 05 04, Basic Electrical Materials and Methods.

D. Apply heat shrinkable tubing or single layer of wraparound duct band to metallic conduit protruding through concrete floor slabs to a point 2 inches above and 2 inches below concrete surface.

E. Concrete Walls, Floors, or Ceilings (Aboveground): Provide nonshrink grout dry-pack, or use watertight seal device.

F. Entering Structures:

1. General: Seal raceway at first box or outlet with oakum or expandable plastic compound to prevent entrance of gases or liquids from one area to another.
2. Concrete Roof or Membrane Waterproofed Wall or Floor:
    a. Provide a watertight seal.
    b. Without Concrete Encasement: Install watertight entrance seal device on each side.
    c. With Concrete Encasement: Install watertight entrance seal device on accessible side.
    d. Securely anchor malleable iron body of watertight entrance seal device into construction with one or more integral flanges.
    e. Secure membrane waterproofing to watertight entrance seal device in a permanent, watertight manner.
3. Heating, Ventilating, and Air Conditioning Equipment:
    a. Penetrate equipment in area established by manufacturer.
    b. Terminate conduit with flexible metal conduit at junction box or condulet attached to exterior surface of equipment prior to penetrating equipment.
    c. Seal penetration with Type 5 sealant, as specified in Section 07 92 00, Joint Sealants.
4. Corrosive-Sensitive Areas:
    a. Seal conduit passing through chemical storage/handling room walls.
    b. Seal conduit entering equipment panel boards and field panels containing electronic equipment.
    c. Seal penetration with Type 5 sealant, as specified in Section 07 92 00, Joint Sealants.
5. Existing or Precast Wall (Underground): Core drill wall and install watertight entrance seal device.
6. Nonwaterproofed Wall or Floor (Underground, without Concrete Encasement):
    a. Provide Schedule 40 galvanized pipe sleeve, or watertight entrance seal device.
    b. Fill space between raceway and sleeve with expandable plastic compound or oakum and lead joint, on each side.
7. Manholes and Handholes:
    a. Metallic Raceways: Provide insulated grounding bushings.
    b. Nonmetallic Raceways: Provide bell ends flush with wall.
    c. Install such that raceways enter as near as possible to one end of wall, unless otherwise shown.

3.07 SUPPORT

A. Support from structural members only, at intervals not exceeding NFPA 70 requirements. Do not exceed 8 feet in any application. Do not support from piping, pipe supports, or other raceways.

B. Multiple Adjacent Raceways: Provide ceiling trapeze. For trapeze-supported conduit, allow 25 percent extra space for future conduit.

C. Application/Type of Conduit Strap:

1. Rigid Steel or EMT Conduit: Zinc coated steel, pregalvanized steel or malleable iron.
2. PVC-Coated Rigid Steel Conduit: PVC-coated metal.
3. Nonmetallic Conduit: Nonmetallic or PVC-coated metal.

D. Provide and attach wall brackets, strap hangers, or ceiling trapeze as follows:

1. Hollow Masonry Units: Toggle bolts.
2. Concrete or Brick: Expansion shields, or threaded studs driven in by powder charge, with lock washers and nuts.
3. Steelwork: Machine screws.
4. Type of Hardware: Type 316 stainless steel.

E. Nails or wooden plugs inserted in concrete or masonry for attaching raceway not permitted. Do not weld raceways or pipe straps to steel structures. Do not use wire in lieu of straps or hangers.

3.08 BENDS

A. Install concealed raceways with a minimum of bends in the shortest practical distance.

B. 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.

C. Install with symmetrical bends or cast metal fittings.

D. Avoid field-made bends and offsets, but where necessary, make with acceptable hickey or bending machine. Do not heat metal raceways to facilitate bending.

E. Make bends in parallel or banked runs from same center or centerline with same radius so that bends are parallel.

F. Factory elbows may be installed in parallel or banked raceways if there is change in plane of run, and raceways are same size.

G. PVC Conduit:

1. Bends 30 Degrees and Larger: Provide factory-made elbows.
2. 90-Degree Bends: Provide rigid steel elbows, PVC-coated where direct buried.
3. Use manufacturer's recommended method for forming smaller bends.

H. Flexible Conduit: Do not make bends that exceed allowable conductor bending radius of cable to be installed or that significantly restricts conduit flexibility.

3.09 EXPANSION/DEFLECTION FITTINGS

A. Provide on raceways at structural expansion joints and in long tangential runs.

B. Provide expansion/deflection joints for 25 degrees F maximum temperature variation.

C. Install in accordance with manufacturer's instructions.

3.10 PVC CONDUIT

A. Solvent Welding:

1. Apply manufacturer recommended solvent to joints.
2. Install in order that joint is watertight.

B. Adapters:

1. PVC to Metallic Fittings: PVC terminal type.
2. PVC to Rigid Metal Conduit or IMC: PVC female adapter.

C. Belled-End Conduit: Bevel unbelled end of joint prior to joining.

3.11 PVC-COATED RIGID STEEL AND RIGID ALUMINUM CONDUIT

A. Install in accordance with manufacturer's instructions.

B. Tools and equipment used in cutting, bending, threading and installation of PVC-coated rigid conduit shall be designed to limit damage to PVC coating.

C. Provide PVC boot to cover exposed threading.

3.12 TERMINATION AT ENCLOSURES

A. Cast Metal Enclosure: Install manufacturer's premolded insulating sleeve inside metallic conduit terminating in threaded hubs.

B. Nonmetallic, Cabinets, and Enclosures:

1. Terminate conduit in threaded conduit hubs, maintaining enclosure integrity.
2. Metallic Conduit: Provide ground terminal for connection to maintain continuity of ground system.

C. Sheet Metal Boxes, Cabinets, and Enclosures:

1. General:
   a. Install insulated bushing on ends of conduit where grounding is not required.
   b. Provide insulated throat when conduit terminates in sheet metal boxes having threaded hubs.
   c. Utilize sealing locknuts or threaded hubs on sides and bottom of NEMA 3R and NEMA 12 enclosures.
   d. Terminate conduits at threaded hubs at the tops of NEMA 3R and NEMA 12 boxes and enclosures.
   e. Terminate conduits at threaded conduit hubs at NEMA 4 and NEMA 4X boxes and enclosures.
2. Rigid Galvanized or Intermediate Conduit:
   a. Provide one lock nut each on inside and outside of enclosure.
   b. Install grounding bushing at source enclosure.
   c. Provide bonding jumper from grounding bushing to equipment ground bus or ground pad.
3. Flexible Metal Conduit: Provide two screw type, insulated, malleable iron connectors.
4. Flexible, Nonmetallic Conduit: Provide nonmetallic, liquid-tight strain relief connectors.
5. PVC-Coated Rigid Galvanized Steel Conduit: Provide PVC-coated, liquid-tight, metallic connector.
6. PVC Schedule 40 Conduit: Provide PVC terminal adapter with lock nut, except where threaded hubs required above.

D. Motor Control Center, Switchgear, and Free-Standing Enclosures:

1. Terminate metal conduit entering bottom with grounding bushing; provide grounding jumper extending to equipment ground bus or grounding pad.
2. Terminate PVC conduit entering bottom with bell end fittings.

3.13 UNDERGROUND RACEWAYS

A. 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.

B. Cover: Maintain minimum 2-foot cover above conduit and concrete encasement, unless otherwise shown.

C. Make routing changes as necessary to avoid obstructions or conflicts.

D. Couplings: In multiple conduit runs, stagger so couplings in adjacent runs are not in same transverse line.

E. Union type fittings not permitted.

F. Spacers:

1. Provide preformed, nonmetallic spacers designed for such purpose, to secure and separate parallel conduit runs in a trench or concrete encasement.
2. 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.

G. Support conduit so as to prevent bending or displacement during backfilling or concrete placement.

H. Transition from Underground to Exposed: PVC-coated rigid steel conduit.

I. Installation with Other Piping Systems:

1. Crossings: Maintain minimum 12-inch vertical separation.
2. Parallel Runs: Maintain minimum 12-inch separation.
3. Installation over valves or couplings not permitted.

J. 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.

K. Provide expansion/deflection fittings in conduit runs that exit building or structure belowgrade. Conduit from building wall to fitting shall be PVC-coated rigid steel.

L. Concrete Encasement: As specified in Section 03 30 00, Cast-in-Place Concrete.

M. Backfill: As specified in Section 31 23 23.15, Trench Backfill.

3.14 UNDER SLAB RACEWAYS

A. Make routing changes as necessary to avoid obstructions or conflicts.

B. Support raceways so as to prevent bending or displacement during backfilling or concrete placement.

C. Install raceways with no part embedded within slab and with no interference with slab on grade construction.

D. Raceway spacing, in a single layer or multiple layers:

1. 3 inches clear between adjacent 2-inch or larger raceway.
2. 2 inches clear between adjacent 1-1/2-inch or smaller raceway.

E. Multiple Layers of Raceways: Install under slab on grade in trench below backfill zone, as specified in Section 31 23 23.15, Trench Backfill.

F. Individual Raceways and Single Layer Multiple Raceways: Install at lowest elevation of backfill zone with spacing as specified herein. Where conduits cross at perpendicular orientation, installation of conduits shall not interfere with placement of under slab fill that meets compaction and void limitations of earthwork specifications.

G. Under slab raceways that emerge from below slab to top of slab as exposed, shall be located to avoid conflicts with structural slab rebar. Coordinate raceway stub ups with location of structural rebar.

H. Fittings:

1. Union type fittings are not permitted.
2. Provide expansion/deflection fittings in raceway runs that exit building or structure below slab. Locate fittings 18 inches, maximum, beyond exterior wall. Raceway type between building exterior wall to fitting shall be PVC-coated rigid steel.
3. Couplings: In multiple raceway runs, stagger so couplings in adjacent runs are not in same traverse line.

3.15 OUTLET AND DEVICE BOXES

A. General:

1. Install plumb and level.
2. Install suitable for conditions encountered at each outlet or device in wiring or raceway system, sized to meet NFPA 70 requirements.
3. Open no more knockouts in sheet steel device boxes than are required; seal unused openings.
4. Install galvanized mounting hardware in industrial areas.

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 device box, unless otherwise required for installed fixture.
3. Switch and Receptacle: Minimum 2-inch by 4-inch 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 Fixture: Install in symmetrical pattern according to room layout, unless otherwise shown.

D. Mounting Height:

1. General:
   a. Dimensions given to centerline of box.
   b. Where specified heights do not suit building construction or finish, adjust up or down to avoid interference.
   c. Do not straddle CMU block or other construction joints.
2. Light Switch:
   a. 48 inches above floor.
   b. When located next to door, install on lock side of door.
3. Thermostat: 54 inches above floor.
4. Telephone Outlet:
   a. 15 inches above floor.
   b. 6 inches above counter tops.
   c. Wall Mounted: 52 inches above floor.
5. Convenience Receptacle:
   a. General Interior Areas: 15 inches above floor.
   b. General Interior Areas (Counter Tops): Install device plate bottom or side flush with top of backsplash, or 6 inches above counter tops without backsplash.
   c. Industrial Areas, Workshops: 48 inches above floor.
   d. Outdoor Areas: 24 inches above finished grade.
6. Switch, Motor Starting: 48 inches above floor, unless otherwise indicated on Drawings.

E. 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.
3. Holes in surrounding surface shall be no larger than required to receive box.

F. Supports:

1. Support boxes independently of conduit by attachment to building structure or structural member.
2. Install bar hangers in frame construction or fasten boxes directly as follows:
   a. Wood: Wood screws.
   b. Concrete or Brick: Bolts and expansion shields.
   c. Hollow Masonry Units: Toggle bolts.
   d. Steelwork: Machine screws.
3. Threaded studs driven in by powder charge and provided with lock washers and nuts are acceptable in lieu of expansion shields.
4. Provide plaster rings where necessary.
5. Boxes embedded in concrete or masonry need not be additionally supported.

G. Install separate junction boxes for flush or recessed lighting fixtures where required by fixture terminal temperature.

H. Boxes Supporting Fixtures: Provide means of attachment with adequate strength to support fixture.

3.16 JUNCTION AND PULL BOXES

A. General:

1. Install plumb and level.
2. Installed boxes shall be accessible.
3. Do not install on finished surfaces.
4. Use outlet boxes as junction and pull boxes wherever possible and allowed by applicable codes.
5. Use conduit bodies as junction and pull boxes where no splices are required and allowed by applicable codes.
6. Install pull boxes where necessary in raceway system to facilitate conductor installation.
7. Install where shown and where necessary to terminate, tap-off, or redirect multiple conduit runs.
8. Install in conduit runs at least every 150 feet or after the equivalent of three right-angle bends.

B. Flush Mounted:

1. Install with concealed conduit.
2. Holes in surrounding surface shall be no larger than required to receive box.
3. Make edges of boxes flush with final surface.

C. Mounting Hardware: Stainless steel.

D. Supports:

1. Support boxes independently of conduit by attachment to building structure or structural member.
2. Install bar hangers in frame construction or fasten boxes directly as follows:
   a. Wood: Wood screws.
   b. Concrete or Brick: Bolts and expansion shields.
   c. Hollow Masonry Units: Toggle bolts.
   d. Steelwork: Machine screws.
3. Threaded studs driven in by powder charge and provided with lock washers and nuts are acceptable in lieu of expansion shields.
4. Boxes embedded in concrete or masonry need not be additionally supported.

E. At or Below Grade:

1. Install boxes for below grade 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.

F. Install Drain/breather fittings in NEMA 250 Type 4 and Type 4X enclosures.

3.17 TELEPHONE AND DATA OUTLET

A. Provide empty 4-11/16-inch square, deep outlet box.

B. Provide blank single gang raised device cover if cables are not installed.

3.18 MANHOLES AND 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 raceway enters at nearly right angle and as near as possible to end of wall, unless otherwise shown.

D. Grounding: As specified in Section 26 05 26, Grounding and Bonding for Electrical Systems.

E. Identification: Field stamp covers with manhole or handhole number as shown. Stamped numbers to be 1-inch minimum height.

3.19 EMPTY RACEWAYS

A. Provide permanent, removable cap over each end.

B. Provide PVC plug with pull tab for underground raceways with end bells.

C. Provide nylon pull cord.

D. Identify, as specified in Article Identification Devices, with waterproof tags attached to pull cord at each end, and at intermediate pull point.

3.20 IDENTIFICATION DEVICES

A. Raceway Tags:

1. Identify origin and destination.
2. For exposed raceways, install tags at each terminus, near midpoint, and at minimum intervals of every 50 feet, whether in ceiling space or surface mounted.
3. Install tags at each terminus for concealed raceways.
4. Provide nylon strap for attachment.

B. Warning Tape: Install approximately 12 inches above underground or concrete-encased raceways. Align parallel to, and within 12 inches of, centerline of run.

C. Buried Raceway Marker:

1. Install at grade to indicate direction of underground raceway.
2. Install at bends and at intervals not exceeding 100 feet in straight runs.
3. Embed and secure to top of concrete base, sized 14 inches long, 6 inches wide, and 8 inches deep; top set flush with finished grade.

3.21 PROTECTION OF INSTALLED WORK

A. Protect products from effects of moisture, corrosion, and physical damage during construction.

B. Provide and maintain manufactured watertight and dust-tight seals over conduit openings during construction.

C. Touch up painted conduit threads after assembly to cover nicks or scars.

D. Touch up coating damage to PVC-coated conduit with patching compound approved by manufacturer. Compound shall be kept refrigerated according to manufacturers' instructions until time of use.

END OF SECTION

SECTION 26 05 70
ELECTRICAL SYSTEMS ANALYSIS

PART 1 GENERAL

1.01 REFERENCES

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

1. American National Standards Institute (ANSI).
2. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
   a. C57.12.00, Standard General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers.
   b. 242, Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems.
   c. 399, Recommended Practice for Industrial and Commercial Power System Analysis.
   d. 1584, Guide for Performing Arc Flash Hazard Calculations.
3. National Electrical Manufacturers Association (NEMA): Z535.4, Product Safety Signs and Labels.
4. National Fire Protection Association (NFPA):
   a. 70, National Electrical Code (NEC).
   b. 70E, Standard for Electrical Safety in the Workplace.
5. Occupational Safety and Health Standards (OSHA): 29 CFR, Part 1910 Subpart S, Electrical.

1.02 SUBMITTALS

A. Action Submittals:

1. Short circuit study.
2. Protective Device Coordination Study: Submit within 90 days after approval of short circuit study.
3. Arc flash study.
4. Arc flash warning labels.

1.03 QUALITY ASSURANCE

A. Short circuit and protective device coordination and arc flash studies shall be prepared by a professional electrical engineer registered in the State of Georgia.

1.04 SEQUENCING AND SCHEDULING

A. Initial complete protective device coordination and arc flash studies shall be submitted within 90 days after approval of initial short circuit study.

B. Final short circuit, protective device coordination, and arc flash studies shall be completed prior to Project Substantial Completion. Final version of study shall include as-installed equipment, materials, and parameter data or settings entered into equipment based on study.

C. Submit final arc flash labels described herein and in compliance with NEMA Z535.4 prior to Project Substantial Completion.

1.05 GENERAL STUDY REQUIREMENTS

A. Equipment and component titles used in the studies shall be identical to equipment and component titles shown on Drawings.

B. Perform studies using one of the following electrical engineering software packages:

1. SKM Power Tools for Windows.
2. ETAP.
3. EDSA.
4. Easy Power.

C. Perform complete fault calculations for each existing source combination.

1. Source combination may include present and future power company supply circuits, large motors, or generators.

D. Utilize proposed and existing load data for study obtained from Contract Documents, from Record Documents provided by Engineer, and from field investigation of system configuration, wiring information, and equipment. Note that these Contract Documents do not depict the full extent of the existing power system.

E. Existing System and Equipment:

1. Extent of existing system to be included in study is all of the existing system and equipment.
2. Include fault contribution of existing motors and equipment in study.
3. Include impedance elements that affect new system and equipment.
4. Include protective devices in series with new equipment.

F. Device coordination time-current curves for low-voltage distribution system; include individual protective device time-current characteristics.

1.06 SHORT CIRCUIT STUDY

A. General:

1. Prepare in accordance with IEEE 399.
2. Use cable impedances based on copper conductors, except where aluminum conductors are specified or shown.
3. Use bus impedances based on copper bus bars, except where aluminum bus bars are specified or shown.
4. Use cable and bus resistances calculated at 25 degrees C.
5. Use medium-voltage cable reactances based on use of typical dimensions of shielded cables with 133 percent insulation levels.
6. Use 600-volt cable reactances based on use of typical dimensions of THHN/THWN conductors.
7. Use transformer impedances 92.5 percent of “nominal” impedance based on tolerances specified in IEEE C57.12.00.

B. Provide:

1. Calculation methods and assumptions.
2. Typical calculation.
3. Tabulations of calculated quantities.
4. Results, conclusions, and recommendations.
5. Selected base per unit quantities.
6. One-line diagrams.
7. Source impedance data, including electric utility system and motor fault contribution characteristics.
8. Impedance diagrams.
9. Zero-sequence impedance diagrams.

C. Calculate short circuit interrupting and momentary (when applicable) duties for an assumed three-phase bolted fault at each:

1. Electric utility’s supply termination point.
2. Main and distribution switchgear.
3. Motor control centers.
4. Standby generators.
5. Branch circuit panelboards.
6. Future load contributions as shown on one-line diagram.

D. Provide bolted line-to-ground fault current study for areas as defined for three-phase bolted fault short circuit study.

E. Provide bolted line-to-line fault current study for areas as defined for three-phase bolted fault short circuit study.

F. Verify:

1. Equipment and protective devices are applied within their ratings.
2. Adequacy of switchgear and motor control centers bus bars to withstand short circuit stresses.
3. Cable and busway sizes for ability to withstand short circuit heating, in addition to normal load currents.

G. Tabulations:

1. General Data:
   a. Short circuit reactances of rotating machines.
   b. Cable and conduit material data.
   c. Bus data.
   d. Transformer data.
   e. Circuit resistance and reactance values.
2. Short Circuit Data (for each source combination):
   a. Fault impedances.
   b. X to R ratios.
   c. Asymmetry factors.
   d. Motor contributions.
   e. Short circuit kVA.
   f. Symmetrical and asymmetrical fault currents.
3. Equipment Evaluation:
   a. Equipment bus bracing, equipment short circuit rating, transformer, cable, busway.
   b. Maximum fault current available.

H. Written Summary:

1. Scope of studies performed.
2. Explanation of bus and branch numbering system.
3. Prevailing conditions.
4. Selected equipment deficiencies.
5. Results of short circuit study.
6. Comments or suggestions.

I. Suggest changes and additions to equipment rating and/or characteristics.

J. Notify Engineer in writing of existing circuit protective devices improperly rated for new fault conditions.

K. Revise data for “as-installed” condition.

1.07 PROTECTIVE DEVICE COORDINATION STUDY

A. General:

1. Prepare in accordance with IEEE 242.
2. Proposed protective device coordination time-current curves for distribution system, graphically displayed on conventional log-log curve sheets.
    a. Provide separate curve sheets for phase and ground fault coordination for each scenario.
    b. Each curve sheet to have title and one-line diagram that applies to specific portion of system associated with time-current curves on that sheet. Limit number of devices shown to four to six.
    c. Identify device associated with each curve by manufacturer type, function, and, if applicable, recommended tap, time delay, instantaneous and other settings recommended.
    d. Terminate device characteristic curves at a point reflecting maximum symmetrical or asymmetrical fault current to which device is exposed.
    e. Apply motor protection methods that comply with NFPA 70.

B. Plot Characteristics on Curve Sheets:

1. Electric utility’s relays.
2. Electric utility’s fuses including manufacturer’s minimum melt, total clearing, tolerance, and damage bands.
3. Medium-voltage equipment relays.
4. Medium-voltage and low-voltage fuses including manufacturer’s minimum melt, total clearing, tolerance, and damage bands.
5. Low-voltage equipment circuit breaker trip devices, including manufacturer tolerance bands.
6. Pertinent transformer full-load currents at 100 percent.
7. Transformer magnetizing inrush currents.
8. Transformer damage curves; appropriate for system operation and location.
9. ANSI transformer withstand parameters.
10. Significant symmetrical and asymmetrical fault currents.
11. Motor overload relay settings for motors greater than 75 horsepower.
12. Ground fault protective device settings.
13. Other system load protective devices for largest branch circuit and feeder circuit breaker in each motor control center.

C. Primary Protective Device Settings for Delta-Wye Connected Transformer:

1. Secondary Line-to-Ground Fault Protection: Primary protective device operating band within transformer's characteristics curve, including a point equal to 58 percent of IEEE C57.12.00 withstand point.
2. Secondary Line-To-Line Faults: 16 percent current margin between primary protective device and associated secondary device characteristic curves.

D. Separate medium voltage relay characteristics curves from curves for other devices by at least 0.4-second time margin.

E. Tabulate Recommended Protective Device Settings:

1. Relays:
   a. Current tap.
   b. Time dial.
   c. Instantaneous pickup.
   d. Electronic settings data file.
2. Circuit Breakers:
   a. Adjustable pickups.
   b. Adjustable time-current characteristics.
   c. Adjustable time delays.
   d. Adjustable instantaneous pickups.
   e. I^2t In/Out.
   f. Zone interlocking.
   g. Electronic settings data file.

F. Written Summary:

1. Scope of studies performed.
2. Summary of protective device coordination methodology.
3. Prevailing conditions.
4. Selected equipment deficiencies.
5. Results of coordination study.
6. Appendix of complete relay and circuit breaker electronic setting files, submit electronic data files from manufacturer's software.
7. Comments or suggestions.

1.08 ARC FLASH STUDY

A. Perform arc flash hazard study after short circuit and protective device coordination study has been completed, reviewed and accepted.

B. Perform arc flash study in accordance with NFPA 70E, OSHA 29 CFR, Part 1910 Subpart S, and IEEE 1584.

C. Base Calculation: For each major part of electrical power system, determine the following:

1. Flash hazard protection boundary.
2. Limited approach boundary.
3. Restricted approach boundary.
4. Prohibited approach boundary.
5. Incident energy level.
6. Personal protection equipment (PPE) hazard/risk category.
7. Type of PPE required.

D. Produce arc flash warning labels that list items in Paragraph Base Calculation and the following additional items.

1. Bus name.
2. Bus voltage.

E. Produce bus detail sheets that list items in Paragraph Base Calculation and the following additional items:

1. Bus name.
2. Upstream protective device name, type, and settings.
3. Bus line-to-line voltage.

F. Produce arc flash evaluation summary sheet listing the following additional items:

1. Bus name.
2. Upstream protective device name, type, settings.
3. Bus line-to-line voltage.
4. Bus bolted fault.
5. Protective device bolted fault current.
6. Arcing fault current.
7. Protective device trip/delay time.
8. Breaker opening time.
9. Solidly grounded column.
10. Equipment type.
11. Gap.
12. Arc flash boundary.
13. Working distance.
14. Incident energy.
15. Required protective fire rated clothing type and class.

G. Analyze short circuit, protective device coordination, and arc flash calculations and highlight equipment that is determined to be underrated or

causes incident energy values greater than 8 cal/cm2. Propose approaches to reduce energy levels.

H. Prepare report summarizing arc flash study with conclusions and recommendations which may affect integrity of electric power distribution system. As a minimum, include the following:

1. Equipment manufacturer's information used to prepare study.
2. Assumptions made during study.
3. Reduced copy of one-line drawing; 11 inches by 17 inches maximum.
4. Arc flash evaluations summary spreadsheet.
5. Bus detail sheets.
6. Arc flash warning labels printed in color on adhesive backed labels.

PART 2 PRODUCTS

2.01 ARC FLASH WARNING LABELS

A. Printed in multicolor on adhesive backed labels. An example label is located following end of section in Figure 1.

PART 3 EXECUTION

3.01 GENERAL

A. Adjust relay and protective device settings according to values established by coordination study.

B. Make minor modifications to equipment as required to accomplish conformance with short circuit and protective device coordination studies.

C. Notify Engineer in writing of required major equipment modifications.

D. Provide laminated one-line diagrams (minimum size 11 inches by 17 inches) to post on interior of electrical room doors.

E. Provide arc flash warning labels on equipment as specified in this section.

3.02 SUPPLEMENTS

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

1. Figure 1: Example Arc Flash Label.

END OF SECTION

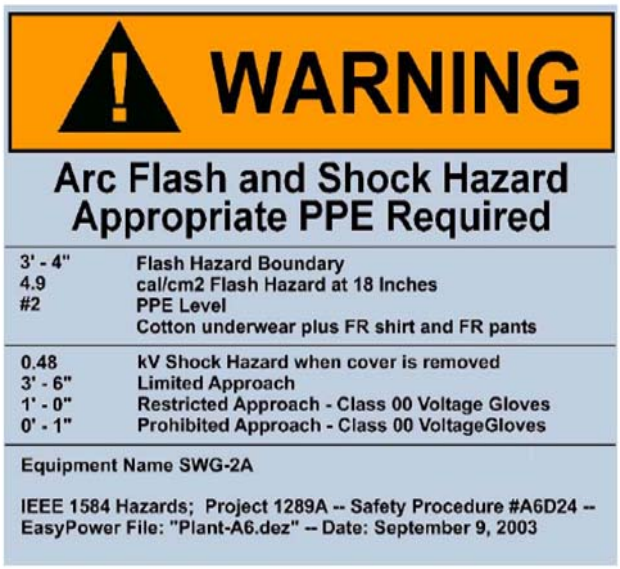


Figure 1
Example Arc Flash Label

SECTION 26 08 00
COMMISSIONING OF ELECTRICAL 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. D877, Standard Test Method for Dielectric Breakdown Voltage of Insulating Liquids Using Disk Electrodes.
   b. D923, Standard Practice for Sampling Electrical Insulating Liquids.
   c. D924, Standard Test Method for Dissipation Factor (or Power Factor) and Relative Permittivity (Dielectric Constant) of Electrical Insulating Liquids.
   d. D971, Standard Test Method for Interfacial Tension of Oil Against Water by the Ring Method.
   e. D974, Standard Test Method for Acid and Base Number by Color-Indicator Titration.
   f. D1298, Standard Test Method for Density, Relative Density (Specific Gravity), or API Gravity of Crude Petroleum and Liquid Petroleum Products by Hydrometer Method.
   g. D1500, Standard Test Method for ASTM Color of Petroleum Products (ASTM Color Scale).
   h. D1524, Standard Test Method for Visual Examination of Used Electrical Insulating Oils of Petroleum Origin in the Field.
   i. D1533, Standard Test Method for Water in Insulating Liquids by Coulometric Karl Fischer Titration.
   j. D1816, Standard Test Method for Dielectric Breakdown Voltage of Insulating Oils of Petroleum Origin Using VDE Electrodes.
2. Institute of Electrical and Electronics Engineers (IEEE):
   a. 43, Recommended Practice for Testing Insulating Resistance of Rotating Machinery.
   b. 48, Standard Test Procedures and Requirements for Alternating-Current Cable Terminators Used on Shielded Cables Having Laminated Insulation Rated 2.5 kV through 765 kV or Extruded Insulation Rated 2.5kV through 500kV.
   c. 81, Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System.
   d. 95, Recommended Practice for Insulation Testing of AC Electric Machinery (2300V and Above) with High Direct Voltage.

e. 386, Standard for Separable Insulated Connector Systems for Power Distribution Systems Above 600V.
f. 400, Guide for Field Testing and Evaluation of the Insulation of Shielded Power Cable Systems.
g. 450, Recommended Practice for Maintenance, Testing, and Replacement of Vented Lead-Acid Batteries for Stationary Applications.
h. C2, National Electrical Safety Code.
i. C37.20.1, Standard for Metal-Enclosed Low Voltage Power Circuit Breaker Switchgear.
j. C37.20.2, Standard for Metal-Clad Switchgear.
k. C37.20.3, Standard for Metal-Enclosed Interrupter Switchgear.
l. C37.23, Standard for Metal-Enclosed Bus.
m. C62.33, Standard Test Specifications for Varistor Surge-Protective Devices.

3. Insulated Cable Engineers Association (ICEA):
   a. S-93-639, 5-46 kV Shielded Power Cables for Use in the Transmission and Distribution of Electric Energy.
   b. S-94-649, Concentric Neutral Cables Rated 5 through 46 kV.
   c. S-97-682, Standard for Utility Shielded Power Cables Rated 5 through 46 kV.
4. National Electrical Manufacturers Association (NEMA):
   a. AB 4, Guidelines for Inspection and Preventive Maintenance of Molded Case Circuit Breakers Used in Commercial and Industrial Applications.
   b. PB 2, Deadfront Distribution Switchboards.
   c. WC 74, 5-46 kV Shielded Power Cable for Use in the Transmission and Distribution of Electric Energy.
5. InterNational Electrical Testing Association (NETA): ATS, Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.
6. National Fire Protection Association (NFPA):
   a. 70, National Electrical Code (NEC).
   b. 70B, Recommended Practice for Electrical Equipment Maintenance.
   c. 70E, Standard for Electrical Safety in the Workplace.
   d. 101, Life Safety Code.
7. National Institute for Certification in Engineering Technologies (NICET).
8. Occupational Safety and Health Administration (OSHA): CFR 29, Part 1910, Occupational Safety and Health Standards.

1.02 SUBMITTALS

A. Informational Submittals:

1. Submit 30 days prior to performing inspections or tests:
   a. Schedule for performing inspection and tests.
   b. List of references to be used for each test.
   c. Sample copy of equipment and materials inspection form(s).
   d. Sample copy of individual device test form.
   e. Sample copy of individual system test form.
2. Energization Plan: Prior to initial energization of electrical distribution equipment; include the following:
   a. Owner's representative sign-off form for complete and accurate arc flash labeling and proper protective device settings for equipment to be energized.
   b. Staged sequence of initial energization of electrical equipment.
   c. Lock-Out-Tag-Out plan for each stage of the progressive energization.
   d. Barricading, signage, and communication plan notifying personnel of newly energized equipment.
3. Submit test or inspection reports and certificates for each electrical item tested within 30 days after completion of test:
4. Operation and Maintenance Data:
   a. In accordance with Section 01 78 23, Operation and Maintenance Data.
   b. After test or inspection reports and certificates have been reviewed by Engineer and returned, insert a copy of each in operation and maintenance manual.
5. Programmable Settings: At completion of Performance Demonstration Test, submit final hardcopy printout and electronic files on compact disc of as-left setpoints, programs, and device configuration files for:
   a. Protective relays.
   b. Intelligent overload relays.
   c. Variable frequency drives.
   d. Power metering devices.
   e. Uninterruptible power supplies.
   f. Electrical communications modules.

1.03 QUALITY ASSURANCE

A. Test equipment shall have an operating accuracy equal to or greater than requirements established by NETA ATS.

B. Test instrument calibration shall be in accordance with NETA ATS.

1.04 SEQUENCING AND SCHEDULING

A. Perform inspection and electrical tests after equipment listed herein has been installed.

B. Perform tests with apparatus de-energized whenever feasible.

C. Inspection and electrical tests on energized equipment shall be:

1. Scheduled with Owner prior to de-energization.
2. Minimized to avoid extended period of interruption to the operating plant equipment.

D. Notify Engineer and Owner at least 72 hours prior to performing tests on energized electrical equipment.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 GENERAL

A. Perform tests in accordance with requirements of Section 01 91 14, Equipment Testing and Facility Startup.

B. Tests and inspections shall establish:

1. Electrical equipment is operational within industry and manufacturer's tolerances and standards.
2. Installation operates properly.
3. Equipment is suitable for energization.
4. Installation conforms to requirements of Contract Documents and NFPA 70, NFPA 70E, NFPA 101, and IEEE C2.

C. Perform inspection and testing in accordance with NETA ATS, industry standards, and manufacturer's recommendations.

D. Set, test, and calibrate circuit and other applicable devices in accordance with values established by short circuit, coordination, and harmonics studies as specified in Section 26 05 70, Electrical Systems Analysis**.**

E. Adjust mechanisms and moving parts of equipment for free mechanical movement.

F. Adjust and set electromechanical electronic relays and sensors to correspond to operating conditions, or as recommended by manufacturer.

G. Verify nameplate data for conformance to Contract Documents and approved Submittals.

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/screw driver to manufacturer's recommendations, or as otherwise specified in NETA ATS.

K. Clean contaminated surfaces with cleaning solvents as recommended by manufacturer.

L. Provide proper lubrication of applicable moving parts.

M. Inform Engineer of working clearances not in accordance with NFPA 70.

N. 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.

O. 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 dented surfaces.
5. Repair or replace, as determined by Engineer poor fitting doors and panel sections.
6. Repair or replace improperly operating latching, locking, or interlocking devices.
7. Replace missing or damaged hardware.
8. Finish:
    a. Provide matching paint and touch up scratches and mars.
    b. If required because of extensive damage, as determined by Engineer, refinish entire assembly.

P. Replace fuses and circuit breakers that do not conform to size and type required by the Contract Documents or approved Submittals.

3.02 CHECKOUT AND STARTUP

A. Equipment Line Current Tests:

1. Check line current in each phase for each piece of equipment.
2. Make line current check after power company has made final adjustments to supply voltage magnitude or balance.
3. If phase current for a piece of equipment is above rated nameplate current, prepare Equipment Line Phase Current Report that identifies cause of problem and corrective action taken.

3.03 SWITCHGEAR ASSEMBLIES

A. Visual and Mechanical Inspection:

1. Insulator damage and contaminated surfaces.
2. Proper barrier and shutter installation and operation.
3. Proper operation of indicating devices.
4. Improper blockage of air-cooling passages.
5. Proper operation of drawout elements.
6. Integrity and contamination of bus insulation system.
7. Check key interlocking systems for:
   a. Key captivity when device is in ON or CLOSED position.
   b. Key removal when device is in ON or CLOSED position.
   c. Closure attempt of device when key has been removed.
   d. Correct number of keys in relationship to number of lock cylinders.
   e. Existence of Other Keys Capable of Operating Lock Cylinders: Destroy duplicate sets of keys.
8. Check nameplates for proper identification of equipment title and tag number with latest one-line diagram
9. Verify fuse and circuit breaker ratings, sizes, and types conform to those specified.
10. Check bus and cable connections for high resistance by low resistance ohmmeter and calibrated torque wrench applied to bolted joints.
    a. Ohmic value to be zero.
    b. Bolt torque level in accordance with NETA ATS, Table 100.12, unless otherwise specified by manufacturer.
11. Check operation and sequencing of electrical and mechanical interlock systems by:
    a. Closure attempt for locked open devices.
    b. Opening attempt for locked closed devices.
    c. Key exchange to operate devices in OFF-NORMAL positions.
12. Verify performance of each control device and feature.

13. Control Wiring:
    a. Compare wiring to local and remote control and protective devices with elementary diagrams.
    b. Proper conductor lacing and bundling.
    c. Proper conductor identification.
    d. Proper conductor lugs and connections.
14. Exercise active components.
15. Perform phasing check on double-ended equipment to ensure proper bus phasing from each source.

B. Electrical Tests:

1. Insulation Resistance Tests:
    a. Applied megohmmeter dc voltage in accordance with NETA ATS, Table 100.1.
    b. Each phase of each bus section.
    c. Phase-to-phase and phase-to-ground for 1 minute.
    d. With breakers open.
    e. With breakers closed.
    f. Control wiring except that connected to solid state components.
    g. Insulation resistance values equal to, or greater than, ohmic values established by manufacturer.
2. Overpotential Tests:
    a. Applied ac or dc voltage and test procedure in accordance with IEEE C37.20.1.
    b. Each phase of each bus section.
    c. Phase-to-phase and phase-to-ground for 1 minute.
    d. Test results evaluated on a pass/fail basis.
3. Current Injection Tests:
    a. For entire current circuit in each section.
    b. Secondary injection for current flow of 1 ampere.
    c. Test current at each device.
4. Control Wiring:
    a. Apply secondary voltage to control power and potential circuits.
    b. Check voltage levels at each point on terminal boards and each device terminal.
5. Operational Test:
    a. Initiate control devices.
    b. Check proper operation of control system in each section.

3.04 PANELBOARDS

A. Visual and Mechanical Inspection: Include the following inspections and related work:

1. Inspect for defects and physical damage, labeling, and nameplate compliance with requirements of up-to-date drawings and panelboard schedules.
2. Exercise and perform operational tests of mechanical components and other operable devices in accordance with manufacturer's instruction manual.
3. Check panelboard mounting, area clearances, and alignment and fit of components.
4. Check tightness of bolted electrical connections with calibrated torque wrench. Refer to manufacturer's instructions for proper torque values.
5. Perform visual and mechanical inspection for overcurrent protective devices.

B. Electrical Tests: Include the following items performed in accordance with manufacturer's instruction:

1. Insulation Resistance Tests:
   a. Applied megohmmeter dc voltage in accordance with NETA ATS, Table 100.1.
   b. Each phase of each bus section.
   c. Phase-to-phase and phase-to-ground for 1 minute.
   d. With breakers open.
   e. With breakers closed.
   f. Control wiring except that connected to solid state components.
   g. Insulation resistance values equal to, or greater than, ohmic values established by manufacturer.
2. Ground continuity test ground bus to system ground.

3.05 DRY TYPE TRANSFORMERS

A. Visual and Mechanical Inspection:

1. Physical and insulator damage.
2. Proper winding connections.
3. Bolt torque level in accordance with NETA ATS, Table 100.12, unless otherwise specified by manufacturer.
4. Defective wiring.
5. Proper operation of fans, indicators, and auxiliary devices.
6. Removal of shipping brackets, fixtures, or bracing.
7. Free and properly installed resilient mounts.
8. Cleanliness and improper blockage of ventilation passages.

9. Verify tap-changer is set at correct ratio for rated output voltage under normal operating conditions.
10. Verify proper secondary voltage phase-to-phase and phase-to-ground after energization and prior to loading.

B. Electrical Tests:

1. Insulation Resistance Tests:
   a. Applied megohmmeter dc voltage in accordance with NETA ATS, Table 100.5 for each:
      1) Winding-to-winding.
      2) Winding-to-ground.
   b. Test Duration: 10 minutes with resistances tabulated at 30 seconds, 1 minute, and 10 minutes.
   c. Results temperature corrected in accordance with NETA ATS, Table 100.14.
   d. Temperature corrected insulation resistance values equal to, or greater than, ohmic values established by manufacturer.
   e. Insulation resistance test results to compare within 1 percent of adjacent windings.
2. Perform tests and adjustments for fans, controls, and alarm functions as suggested by manufacturer.

3.06 LOW VOLTAGE CABLES, 600 VOLTS MAXIMUM

A. Visual and Mechanical Inspection:

1. Inspect each individual exposed power cable No. 1 and larger for:
   a. Physical damage.
   b. Proper connections in accordance with single-line diagram.
   c. Cable bends not in conformance with manufacturer’s minimum allowable bending radius where applicable.
   d. Color coding conformance with specification.
   e. Proper circuit identification.
2. Mechanical Connections for:
   a. Proper lug type for conductor material.
   b. Proper lug installation.
   c. Bolt torque level in accordance with NETA ATS, Table 100.12, unless otherwise specified by manufacturer.
3. Shielded Instrumentation Cables for:
   a. Proper shield grounding.
   b. Proper terminations.
   c. Proper circuit identification.
4. Control Cables for:
   a. Proper termination.
   b. Proper circuit identification.

5. Cables Terminated Through Window Type CTs: Verify neutrals and grounds are terminated for correct operation of protective devices.

B. Electrical Tests for Conductors No. 1 and Larger:

1. Insulation Resistance Tests:
   a. Utilize 1,000-volt dc megohmmeter for 600-volt insulated conductors.
   b. Test each conductor with respect to ground and to adjacent conductors for 1 minute.
   c. Evaluate ohmic values by comparison with conductors of same length and type.
   d. Investigate values less than 50 megohms.
2. Continuity test by ohmmeter method to ensure proper cable connections.

C. Low-voltage cable tests may be performed by installer in lieu of independent testing firm.

3.07 MOLDED AND INSULATED CASE CIRCUIT BREAKERS

A. General: Inspection and testing limited to circuit breakers rated 100 amperes and larger and to motor circuit protector breakers rated 100 amperes and larger.

B. Visual and Mechanical Inspection:

1. Proper mounting.
2. Proper conductor size.
3. Feeder designation according to nameplate and one-line diagram.
4. Cracked casings.
5. Connection bolt torque level in accordance with NETA ATS, Table 100.12.
6. Operate breaker to verify smooth operation.
7. Compare frame size and trip setting with circuit breaker schedules or one-line diagram.
8. Verify that terminals are suitable for 75 degrees C rated insulated conductors.

C. Electrical Tests:

1. Insulation Resistance Tests:
   a. Utilize 1,000-volt dc megohmmeter for 480-volt and 600-volt circuit breakers and 500-volt dc megohmmeter for 240-volt circuit breakers.
   b. Pole-to-pole and pole-to-ground with breaker contacts opened for 1 minute.

c. Pole-to-pole and pole-to-ground with breaker contacts closed for 1 minute.
d. Test values to comply with NETA ATS, Table 100.1.

2. Contact Resistance Tests:
   a. Contact resistance in microhms across each pole.
   b. Investigate deviation of 50 percent or more from adjacent poles and similar breakers.
3. Primary Current Injection Test to Verify:
   a. Long-time minimum pickup and delay.
   b. Short-time pickup and delay.
   c. Ground fault pickup and delay.
   d. Instantaneous pickup by run-up or pulse method.
   e. Trip characteristics of adjustable trip breakers shall be within manufacturer's published time-current characteristic tolerance band, including adjustment factors.
   f. Trip times shall be within limits established by NEMA AB 4, Table 5-3. Alternatively, use NETA ATS, Table 100.7.
   g. Instantaneous pickup value shall be within values established by NEMA AB 4, Table 5-4. Alternatively, use NETA ATS, Table 100.8.

3.08 LOW VOLTAGE POWER CIRCUIT BREAKERS

A. Visual and Mechanical Inspection:

1. Proper mounting, cell fit, and element alignment.
2. Proper operation of racking interlocks.
3. Check for damaged arc chutes.
4. Proper contact condition.
5. Bolt torque level in accordance with NETA ATS, Table 100.12.
6. Perform mechanical operational and contact alignment tests in accordance with manufacturer's instructions.
7. Check operation of closing and tripping functions of trip devices by activating ground fault relays, undervoltage shunt relays, and other auxiliary protective devices.
8. Verify primary and secondary contact wipe, gap setting, and other dimensions vital to breaker operation are correct.
9. Check charging motor, motor brushes, associated mechanism, and limit switches for proper operation and condition.
10. Check operation of electrically operated breakers in accordance with manufacturer's instructions.
11. Check for adequate lubrication on contact, moving, and sliding surfaces.

B. Electrical Tests:

1. Insulation Resistance Tests:
   a. Utilize 1,000-volt dc megohmmeter for 480-volt and 600-volt circuit breakers.
   b. Pole-to-pole and pole-to-ground with breaker contacts opened for 1 minute.
   c. Pole-to-pole and pole-to-ground with breaker contacts closed for 1 minute.
   d. Test values to comply with NETA ATS, Table 100.1.
2. Contact Resistance Tests:
   a. Contact resistance in microhms across each pole.
   b. Investigate deviation of 50 percent or more from adjacent poles and similar breakers.
3. Primary Current Injection Test to Verify:
   a. Long-time minimum pickup and delay.
   b. Short-time pickup and delay.
   c. Ground fault pickup and delay.
   d. Instantaneous pickup by run-up or pulse method.
   e. Trip characteristic when adjusted to setting sheet parameters shall be within manufacturer's published time-current tolerance band.

3.09 INSTRUMENT TRANSFORMERS

A. Visual and Mechanical Inspection:

1. Visually check current, potential, and control transformers for:
   a. Cracked insulation.
   b. Broken leads or defective wiring.
   c. Proper connections.
   d. Adequate clearances between primary and secondary circuit wiring.
2. Verify Mechanically:
   a. Grounding and shorting connections have good contact.
   b. Withdrawal mechanism and grounding operation, when applicable, operate properly.
3. Verify proper primary and secondary fuse sizes for potential transformers.

B. Electrical Tests:

1. Current Transformer Tests:
   a. Insulation resistance test of transformer and wiring-to-ground at 1,000 volts dc for 30 seconds.
   b. Polarity test.

2. Potential Transformer Tests:
    a. Insulation resistance test at test voltages in accordance with NETA ATS, Table 100.9, for 1 minute on:
        1) Winding-to-winding.
        2) Winding-to-ground.
    b. Polarity test to verify polarity marks or H1-X1 relationship as applicable.
3. Insulation resistance measurement on instrument transformer shall not be less than that shown in NETA ATS, Table 100.5.

3.10 METERING

A. Visual and Mechanical Inspection:

1. Verify meter connections in accordance with appropriate diagrams.
2. Verify meter multipliers.
3. Verify meter types and scales conform to Contract Documents.
4. Check calibration of meters at cardinal points.
5. Check calibration of electrical transducers.

3.11 GROUNDING SYSTEMS

A. Visual and Mechanical Inspection:

1. Equipment and circuit grounds in motor control center, panelboard, and switchgear assemblies for proper connection and tightness.
2. Ground bus connections in motor control center, panelboard, and switchgear assemblies for proper termination and tightness.
3. Effective transformer core and equipment grounding.
4. Accessible connections to grounding electrodes for proper fit and tightness.
5. Accessible exothermic-weld grounding connections to verify that molds were fully filled and proper bonding was obtained.

B. Electrical Tests:

1. Fall-of-Potential Test:
    a. In accordance with IEEE 81, Section 8.2.1.5 for measurement of main ground system’s resistance.
    b. Main ground electrode system resistance to ground to be no greater than 1 ohm.

3.12 AC INDUCTION MOTORS

A. General: Inspection and testing limited to motors rated 60 horsepower and larger.

B. Visual and Mechanical Inspection:

1. Proper electrical and grounding connections.
2. Shaft alignment.
3. Blockage of ventilating air passageways.
4. Operate motor and check for:
    a. Excessive mechanical and electrical noise.
    b. Overheating.
    c. Correct rotation.
    d. Check vibration detectors, resistance temperature detectors, or motor inherent protectors for functionability and proper operation.
    e. Excessive vibration, in excess of values in NETA ATS, Table 100.10.
5. Check operation of space heaters.

C. Electrical Tests:

1. Insulation Resistance Tests:
    a. In accordance with IEEE 43 at test voltages established by NETA ATS, Table 100.1 for:
        1) Motors above 200 horsepower for 10-minute duration with resistances tabulated at 30 seconds, 1 minute, and 10 minutes.
        2) Motors 200 horsepower and less for 1-minute duration with resistances tabulated at 30 seconds and 60 seconds.
    b. Insulation resistance values equal to, or greater than, ohmic values established by manufacturers.
2. Calculate polarization index ratios for motors above 200 horsepower. Investigate index ratios less than 1.5 for Class A insulation and 2.0 for Class B insulation.
3. Insulation resistance test on insulated bearings in accordance with manufacturer’s instructions.
4. Measure running current and voltage, and evaluate relative to load conditions and nameplate full-load amperes.

3.13 LOW-VOLTAGE MOTOR CONTROL

A. Visual and Mechanical Inspection:

1. Proper barrier and shutter installation and operation.
2. Proper operation of indicating and monitoring devices.
3. Proper overload protection for each motor.
4. Improper blockage of air-cooling passages.
5. Proper operation of drawout elements.
6. Integrity and contamination of bus insulation system.

7. Check door and device interlocking system by:
   a. Closure attempt of device when door is in OFF or OPEN position.
   b. Opening attempt of door when device is in ON or CLOSED position.
8. Check nameplates for proper identification of equipment title and tag number with latest one-line diagram.
9. Verify fuse and circuit breaker sizes and types conform to Contract Documents.
10. Verify current and potential transformer ratios conform to Contract Documents.
11. Check bus connections for high resistance by low-resistance ohmmeter and calibrated torque wrench applied to bolted joints:
    a. Ohmic value to be zero.
    b. Bolt torque level in accordance with NETA ATS, Table 100.12, unless otherwise specified by manufacturer.
12. Check operation and sequencing of electrical and mechanical interlock systems by:
    a. Closure attempt for locked open devices.
    b. Opening attempt for locked closed devices.
    c. Key exchange to operate devices in OFF-NORMAL positions.
13. Verify performance of each control device and feature furnished as part of motor control center.
14. Control Wiring:
    a. Compare wiring to local and remote control, and protective devices with elementary diagrams.
    b. Check for proper conductor lacing and bundling.
    c. Check for proper conductor identification.
    d. Check for proper conductor lugs and connections.
15. Exercise active components.
16. Inspect contactors for:
    a. Correct mechanical operations.
    b. Correct contact gap, wipe, alignment, and pressure.
    c. Correct torque of connections.
17. Compare overload heater rating with full-load current for proper size.
18. Compare motor protector and circuit breaker with motor characteristics for proper size.
19. Perform phasing check on double-ended motor control centers to ensure proper bus phasing from each source.

B. Electrical Tests:

1. Insulation Resistance Tests:
   a. Applied megohmmeter dc voltage in accordance with NETA ATS, Table 100.1.
   b. Bus section phase-to-phase and phase-to-ground for 1 minute on each phase.

c. Contactor phase-to-ground and across open contacts for 1 minute on each phase.
d. Starter section phase-to-phase and phase-to-ground on each phase with starter contacts closed and protective devices open.
e. Test values to comply with NETA ATS, Table 100.1.

2. Current Injection through Overload Unit at 300 Percent of Motor Full-Load Current and Monitor Trip Time:
   a. Trip time in accordance with manufacturer's published data.
   b. Investigate values in excess of 120 seconds.
3. Control Wiring Tests:
   a. Apply secondary voltage to control power and potential circuits.
   b. Check voltage levels at each point on terminal board and each device terminal.
   c. Insulation resistance test at 1,000 volts dc on control wiring, except that connected to solid state components; 1 megohm minimum insulation resistance.
4. Operational test by initiating control devices to affect proper operation.

END OF SECTION

SECTION 26 20 00
LOW-VOLTAGE AC INDUCTION MOTORS

PART 1 GENERAL

1.01 RELATED SECTIONS

A. This section applies only when referenced by a motor-driven equipment specification. Application, horsepower, enclosure type, mounting, shaft type, synchronous speed, and deviations from this section will be listed in the equipment specification. Where such deviations occur, they shall take precedence over this section.

1.02 REFERENCES

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

1. American Bearing Manufacturers Association (ABMA):
   a. 9, Load Ratings and Fatigue Life for Ball Bearings.
   b. 11, Load Ratings and Fatigue Life for Roller Bearings.
2. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
   a. 112, Standard Test Procedure for Polyphase Induction Motors and Generators.
   b. 620, Guide for the Presentation of Thermal Limit Curves for Squirrel Cage Induction Machines.
   c. 841, Standard for Petroleum and Chemical Industry—Premium Efficiency Severe Duty Totally Enclosed Fan-Cooled (TEFC) Squirrel Cage Induction Motors—Up to and Including 370 kW (500 hp).
3. National Electrical Manufacturers Association (NEMA):
   a. 250, Enclosures for Electrical Equipment (1,000 Volts Maximum).
   b. C50.41, Polyphase Induction Motors for Power Generating Stations.
   c. MG 1, Motors and Generators.
4. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC).
5. Underwriters Laboratories (UL):
   a. 83, Standard for Safety for Thermoplastic-Insulated Wire and Cables.
   b. 674, Standard for Safety for Electric Motors and Generators for Use in Division 1 Hazardous (Classified) Locations.
   c. 2111, Standard for Safety for Overheating Protection for Motors.

1.03 DEFINITIONS

A. CISD-TEFC: Chemical industry, severe-duty enclosure.

B. DIP: Dust-ignition-proof enclosure.

C. EXP: Explosion-proof enclosure.

D. Inverter Duty Motor: Motor meeting applicable requirements of NEMA MG 1, Section IV, Parts 30 and 31.

E. Motor Nameplate Horsepower: That rating after any derating required to allow for extra heating caused by the harmonic content in the voltage applied to the motor by its controller.

F. ODP: Open drip-proof enclosure.

G. TEFC: Totally enclosed, fan-cooled enclosure.

H. TENV: Totally enclosed, nonventilated enclosure.

I. WPI: Open weather protected enclosure, Type I.

J. WPII: Open weather protected enclosure, Type II.

1.04 SUBMITTALS

A. Action Submittals:

1. Descriptive information.
2. Nameplate data in accordance with NEMA MG 1.
3. Additional Rating Information:
    a. Service factor.
    b. Locked rotor current.
    c. No load current.
    d. Safe stall time for motors 60 hp and larger.
    e. Adjustable frequency drive motor load classification (for example, variable torque) and minimum allowable motor speed for that load classification.
4. Enclosure type and mounting (such as, horizontal, vertical).
5. Dimensions and total weight.
6. Conduit box dimensions and usable volume as defined in NEMA MG 1 and NFPA 70.
7. Bearing type.
8. Bearing lubrication.
9. Bearing life.
10. Space heater voltage and watts.

11. Description, ratings, and wiring diagram of motor thermal protection.
12. Motor sound power level in accordance with NEMA MG 1.
13. Maximum brake horsepower required by the equipment driven by the motor.
14. Seismic anchorage and bracing data sheets and drawings as required by Section 01 88 15, Anchorage and Bracing.

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. Operation and Maintenance Data: As specified in Section 01 78 23, Operation and Maintenance Data.
4. Manufacturer's Certificate of Proper Installation, in accordance with Section 01 43 33, Manufacturers' Field Services.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Materials, equipment, and accessories specified in this section shall be products of:

1. General Electric.
2. Reliance Electric.
3. Baldor.
4. U.S. Electrical Motors.
5. TECO-Westinghouse Motor Co.
6. Toshiba International Corp., Industrial Division.
7. WEG Electric Motors Corp.

2.02 GENERAL

A. For multiple units of the same type of equipment, furnish identical motors and accessories of a single manufacturer.

B. In order to obtain single source responsibility, use a single supplier to provide drive motor, its driven equipment, and specified motor accessories.

C. Meet requirements of NEMA MG 1.

D. For motors used in hazardous (classified) locations, Class I, Division 1, Groups B, C, and D, and Class II, Division 1, Groups E, F, and G provide motors that conform to UL 674 and have an applied UL listing mark.

E. Motors shall be specifically designed for the use and conditions intended, with a NEMA design letter classification to fit the application.

F. Lifting lugs on motors weighing 100 pounds or more.

G. Operating Conditions:

1. Maximum ambient temperature not greater than 50 degrees C.
2. Motors shall be suitable for operating conditions without reduction being required in nameplate rated horsepower or exceeding rated temperature rise.
3. Overspeed in either direction in accordance with NEMA MG 1.

2.03 HORSEPOWER RATING

A. As designated in motor-driven equipment specification.

B. Constant Speed Applications: Brake horsepower of driven equipment at any head capacity point on pump curve not to exceed motor nameplate horsepower rating, excluding service factor.

C. Adjustable Frequency and Adjustable Speed Applications (Inverter Duty Motor): Driven equipment brake horsepower at any head capacity point on pump curve not to exceed motor nameplate horsepower rating, excluding service factor.

2.04 SERVICE FACTOR

A. Inverter-duty Motors: 1.0 at rated ambient temperature, unless otherwise noted.

B. Other Motors: 1.15 minimum at rated ambient temperature, unless otherwise noted.

2.05 VOLTAGE AND FREQUENCY RATING

A. System Frequency: 60 Hz.

B. Voltage Rating: Unless otherwise indicated in motor-driven equipment specification:

Voltage Rating		
Size	**Voltage**	**Phase**
1/2 hp and smaller	115	1
3/4 hp through larger	460	3

C. Suitable for full voltage starting.

D. 200 hp and larger also suitable for reduced voltage starting with 65 percent or 80 percent voltage tap settings on reduced inrush motor starters.

E. Suitable for accelerating the connected load with supply voltage at motor starter supply terminals dipping to 90 percent of motor rated voltage.

2.06 EFFICIENCY AND POWER FACTOR

A. For all motors except single-phase, under 1 hp, multispeed, short-time rated and submersible motors, or motors driving gates, valves, elevators, cranes, trolleys, and hoists:

1. Efficiency:
   a. Tested in accordance with NEMA MG 1, Paragraph 12.59.
   b. Guaranteed minimum at full load in accordance with NEMA MG 1 Table 12-12, Full-load Efficiencies for NEMA Premium Efficiency Electric Motors Rated 600 Volts or Less (Random Wound), or as indicated in motor-driven equipment specification.
2. Power Factor: Guaranteed minimum at full load shall be manufacturer's standard or as indicated in motor-driven equipment specification.

2.07 LOCKED ROTOR RATINGS

A. Locked rotor kVA Code G or lower, if motor horsepower not covered by NEMA MG 1 tables.

B. Safe Stall Time: 12 seconds or greater.

2.08 INSULATION SYSTEMS

A. Single-Phase, Fractional Horsepower Motors: Manufacturer's standard winding insulation system.

B. Motors Rated Over 600 Volts: Sealed windings in accordance with NEMA MG 1.

C. Three-phase and Integral Horsepower Motors: Unless otherwise indicated in motor-driven equipment specification, Class F with Class B rise at nameplate horsepower and designated operating conditions.

2.09 ENCLOSURES

A. Enclosures to conform to NEMA MG 1.

B. TEFC and TENV: Furnish with drain hole with porous drain/weather plug.

C. Explosion-Proof (EXP):

1. TEFC listed to meet UL 674 and NFPA 70 requirements for Class I, Division 1, Group D hazardous locations.
2. Drain holes with drain and breather fittings.
3. Integral thermostat opening on excessive motor temperature in accordance with UL 2111 and NFPA 70.
4. Terminate thermostat leads in terminal box separate from main terminal box.

D. Dust-Ignition-Proof (DIP):

1. TEFC listed to meet UL 674 and NFPA 70 requirements for Class II, Division 1, Group F.
2. Integral thermostat opening on excessive motor temperature in accordance with UL 2111 and NFPA 70.
3. Thermostat leads to terminate in a terminal box separate from main terminal box.

E. Submersible: In accordance with Article Special Motors.

F. Chemical Industry, Severe-Duty (CISD-TEFC): In accordance with Article Special Motors.

2.10 TERMINAL (CONDUIT) BOXES

A. Oversize main terminal boxes for motors.

B. Diagonally split, rotatable to each of four 90-degree positions. Threaded hubs for conduit attachment.

C. Except ODP, furnish gaskets between box halves and between box and motor frame.

D. Minimum usable volume in percentage of that specified in NEMA MG 1, Section 1, Paragraph 4.19 and NFPA 70, Article 430:

Terminal Box Usable Values		
Voltage	**Horsepower**	**Percentage**
Below 600	15 through 125	500
Below 600	150 through 300	275
Below 600	350 through 600	225
Above 600	All sizes	200

E. Terminal for connection of equipment grounding wire in each terminal box.

F. Coordinate motor terminal box conduit entries versus size and quantity of conduits shown on Drawings.

2.11 BEARINGS AND LUBRICATION

A. Horizontal Motors:

1. 3/4 hp and Smaller: Permanently lubricated and sealed ball bearings, or regreasable ball bearings in labyrinth sealed end bells with removable grease relief plugs.
2. 1 hp through 400 hp: Regreasable ball bearings in labyrinth sealed end bells with removable grease relief plugs.
3. Minimum 100,000 hours L-10 bearing life for ball and roller bearings as defined in ABMA 9 and ABMA 11.

B. Vertical Motors:

1. Thrust Bearings:
   a. Antifriction bearing.
   b. Manufacturer’s standard lubrication 100 hp and smaller.
   c. Oil lubricated 125 hp and larger.
   d. Minimum 50,000 hours L-10 bearing life.
2. Guide Bearings:
   a. Manufacturer’s standard bearing type.
   b. Manufacturer’s standard lubrication 200 hp and smaller.
   c. Oil lubricated 250 hp and larger.
   d. Minimum 100,000 hours L-10 bearing life.

C. Regreasable Antifriction Bearings:

1. Readily accessible, grease injection fittings.
2. Readily accessible, removable grease relief plugs.

D. Oil Lubrication Systems:

1. Oil reservoirs with sight level gauge.
2. Oil fill and drain openings with opening plugs.
3. Provisions for necessary oil circulation and cooling.

E. Inverter Duty Rated Motors, Bearing Isolation: Motors larger than 50 hp shall have electrically isolated bearings to prevent stray current damage.

2.12 NOISE

A. Measured in accordance with NEMA MG 1.

B. Motors controlled by adjustable frequency drive systems shall not exceed sound levels of 3 dBA higher than NEMA MG 1.

2.13 BALANCE AND VIBRATION CONTROL

A. In accordance with NEMA MG 1, Part 7.

2.14 EQUIPMENT FINISH

A. Protect Motor for Service Conditions:

1. ODP Enclosures: Indoor industrial atmospheres.
2. Other Enclosures: Outdoor industrial atmospheres, including moisture and direct sunlight exposure.

B. External Finish: Prime and finish coat manufacturer’s standard.

C. Internal Finish: Bore and end turns coated with clear polyester or epoxy varnish.

2.15 SPECIAL FEATURES AND ACCESSORIES

A. Screen Over Air Openings: Stainless steel on motors with ODP, WPI, and WPII enclosures meeting requirements for guarded machine in NEMA MG 1, and attached with stainless steel screws.

B. Winding Thermal Protection:

1. Thermostats:
   a. Motors for constant speed application100 hp and larger; motors for adjustable speed application 40 hp and larger.
   b. Bi-metal disk or rod type thermostats embedded in stator windings.
   c. Automatic reset contacts rated 120 volts ac, 5 amps minimum, opening on excessive temperature. (Provide manual reset at motor controller.)
   d. Leads extending to separate terminal box for motors 100 hp and larger.

C. Space Heaters:

1. Provide winding space heaters with leads wired out to motor terminal box.
2. Provide extra hole or hub on motor terminal box as required.
3. Unless shown otherwise, heater shall be suitable for 120V ac supply, with wattage suitable for motor frame size.

D. Nameplates:

1. Raised or stamped letters on stainless steel or aluminum.
2. Display motor data required by NEMA MG 1, Paragraph 10.39 and Paragraph 10.40 in addition to bearing numbers for both bearings.
3. Premium efficiency motor nameplates to display NEMA nominal efficiency, guaranteed minimum efficiency, full load power factor, and maximum allowable kVAR for power factor correction capacitors.

E. Anchor Bolts: Provide meeting manufacturer’s recommendations and of sufficient size and number for specified seismic condition.

2.16 SPECIAL MOTORS

A. Requirements in this article take precedence over conflicting features specified elsewhere in this section.

B. Chemical Industry, Severe-Duty (CISD-TEFC):

1. In accordance with IEEE 841.
2. TEFC in accordance with NEMA MG 1.
3. Suitable for indoor or outdoor installation in severe-duty applications including high humidity, chemical (corrosive), dirty, or salty atmospheres.
4. Motor Frame, End Shields, Terminal Box, and Fan Cover: Cast iron.
5. Ventilating Fan: Corrosion-resistant, nonsparking, external.
6. Drain and Breather Fittings: Stainless steel.

7. Nameplate: Stainless steel.
8. Gaskets between terminal box halves and terminal box and motor frame.
9. Extra slinger on rotor shaft to prevent moisture seepage along shaft into motor.
10. Double shielded bearings.
11. 125,000 hours minimum L-10 bearing life for direct-connected loads.
12. External Finish: Double-coated epoxy enamel.
13. Coated rotor and stator air gap surfaces.
14. Insulation System, Windings, and Connections:
    a. Class F insulation, Class B rise or better at 1.0 service factor.
    b. Multiple dips and bakes of nonhygroscopic polyester varnish.
15. Service Factor:
    a. At 40 Degrees C Ambient: 1.15.
    b. At 65 Degrees C Ambient: 1.00.
16. Safe Stall Time Without Injurious Heating: 20 seconds minimum.

C. Severe-duty Explosion-proof: Meet requirements for EXP enclosures and CISD-TEFC motors.

D. Severe-duty, Dust-ignition-proof: Meet requirements for DIP enclosures and CISD-TEFC motors.

E. Multispeed: Meet requirements for speeds, number of windings, and load torque classification indicated in motor-driven equipment specification.

F. Inverter Duty Motor:

1. Motor supplied power by adjustable voltage and adjustable frequency drives shall be inverter duty rated.
2. Suitable for operation over entire speed range indicated.
3. Provide forced ventilation where speed ratio is greater than published range for motor provided.
4. When installed in Division 1 hazardous (classified) location shall be identified as acceptable for variable speed when used in Division 1 location.
5. Shaft Grounding Device: Motors larger than 20 hp shall be provided with shaft grounding brush or conductive micro fiber shaft grounding ring. Shaft grounding device shall be solidly bonded to grounded motor frame per manufacturer’s recommendations.
    a. Manufacturers:
        1) Grounding Brush: Sohre Turbomachinery, Inc.
        2) Grounding Ring: EST-Aegis.

2.17 FACTORY TESTING

A. Tests:

1. In accordance with IEEE 112 for polyphase motors.
2. Routine (production) tests in accordance with NEMA MG 1. Test multispeed motors at all speeds.
3. For energy efficient motors, test efficiency and power factor at 50 percent, 75 percent, and 100 percent of rated horsepower:
   a. In accordance with IEEE 112, Test Method B, and NEMA MG 1, Paragraph 12.59. and Paragraph 12.60.
   b. For motors 500 hp and larger where facilities are not available to test by dynamometer (Test Method B), determine efficiency by IEEE 112, Test Method F.
4. Provide test reports for polyphase motors 100 hp and larger.

B. Test Report Forms:

1. Routine Tests: IEEE 112, Form A-1.
2. Efficiency and power factor by Test Method B, IEEE 112, Form A-2, and NEMA MG 1, Table 12-11.
3. Temperature Test: IEEE 112, Form A-2.

PART 3 EXECUTION

3.01 INSTALLATION

A. In accordance with manufacturer’s instructions and recommendations.

B. Align motor carefully and properly with driven equipment.

C. Secure equipment to mounting surface with anchor bolts.

3.02 MANUFACTURER’S SERVICES

A. Manufacturer’s Certificate of Proper Installation.

END OF SECTION

SECTION 26 22 00
LOW-VOLTAGE TRANSFORMERS

PART 1 GENERAL

1.01 REFERENCES

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

1. Institute of Electrical and Electronics Engineers (IEEE): C57.96, Guide for Loading Dry Type Transformers.
2. National Electrical Contractor's Association (NECA): 409, Recommended Practice for Installing and Maintaining Dry-Type Transformers.
3. National Electrical Manufacturers Association (NEMA):
   a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
   b. ST 20, Dry-Type Transformers for General Applications.
   c. TP 1, Guide For Determining Energy Efficiency for Distribution Transformers.
4. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC).
5. Underwriters Laboratories Inc. (UL):
   a. 486E, Standard for Equipment Wiring Terminals for use with Aluminum and/or Copper Conductors.
   b. 489, Standard for Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit Breaker Enclosures.
   c. 1561, Standard for Dry-Type, General Purpose, and Power Transformers.

1.02 SUBMITTALS

A. Action Submittals:

1. Descriptive information.
2. Dimensions and weight.
3. Transformer nameplate data.
4. Schematic and connection diagrams.
5. Seismic anchorage and bracing drawings and cut sheets, as required by Section 01 88 15, Anchorage and Bracing.

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.

PART 2 PRODUCTS

2.01 GENERAL

A. UL 1561, NEMA ST 20, unless otherwise indicated.

B. Dry-type, self-cooled, two-winding, with aluminum or copper windings.

C. Units larger than 5 kVA suitable for use with 75 degrees C wire at full NFPA 70, 75 degrees C ampacity.

D. Efficiency: Meet or exceed values in Table 4.2 of NEMA TP 1.

E. Maximum Sound Level per NEMA ST 20:

1. 40 decibels for 0 kVA to 9 kVA.
2. 45 decibels for 10 kVA to 50 kVA.

F. Overload capability: Short-term overload per IEEE C57.96.

G. Wall Bracket: For single-phase units, 15 kVA to 37-1/2 kVA, and for three-phase units, 15 kVA to 30 kVA.

H. Vibration Isolators:

1. Rated for transformer’s weight.
2. Isolation Efficiency: 99 percent, at fundamental frequency of sound emitted by transformer.
3. Less Than 30 kVA: Isolate entire unit from structure with external vibration isolators.
4. 30 kVA and Above: Isolate core and coil assembly from transformer enclosure with integral vibration isolator.

I. Manufacturers:

1. General Electric Co.
2. Square D Co.
3. Eaton/Cutler-Hammer.

2.02 MINI-POWER CENTER (MPC)

A. General: Transformer, primary and secondary main circuit breakers, and secondary panelboard section enclosed in NEMA 250, 4X, Type 316 stainless steel enclosure.

B. Transformer:

1. Insulation Class and Temperature Rise: Manufacturer's standard.
2. Core and Coil: Encapsulated.
3. Full capacity, 2-1/2 percent voltage taps, two above and two below normal voltage.
4. Primary Voltage: 480, three-phase.
5. Secondary Voltage: 208/120 volts, three-phase, four-wire.

C. Panelboard: Full, UL 489, short-circuit current rated.

1. Type: Thermal-magnetic, quick-make, quick-break, indicating, with noninterchangeable molded case circuit breakers.
2. Number and Breaker Ampere Ratings: Refer to Panel Schedule.

2.03 GENERAL PURPOSE TRANSFORMER

A. Insulation Class and Temperature Rise: Manufacturer's standard.

B. Core and Coil:

1. Encapsulated for single-phase units 1/2 kVA to 25 kVA and for three-phase units 3 kVA to 15 kVA.
2. Thermosetting varnish impregnated for single-phase units 37.5 kVA and above, and for three-phase units 30 kVA and above.

C. Enclosure:

1. Single-Phase, 3 kVA to 25 kVA: NEMA 250, Type 3R, nonventilated.
2. Single-Phase, 37-1/2 kVA and Above: NEMA 250, Type 2, ventilated.
3. Three-Phase, 3 kVA to 15 kVA: NEMA 250, Type 3R, nonventilated.
4. Three-Phase, 30 kVA and Above: NEMA 250, Type 2, ventilated.
5. Outdoor Locations: NEMA 250, Type 3R.
6. Corrosive Locations: NEMA 250, Type 3R stainless steel.

D. Voltage Taps:

1. Single-Phase, 3 kVA to 10 kVA: Four 2-1/2 percent, full capacity; two above and two below normal voltage rating.
2. Single-Phase, 15 kVA and Above: Four 2-1/2 percent, full capacity; two above and two below normal voltage rating.
3. Three-Phase, 3 kVA to 15 kVA: Four 2-1/2 percent, full capacity; two above and two below normal voltage rating.
4. Three-Phase, 30 kVA and Above: Four 2-1/2 percent, full capacity; two above and two below normal voltage rating.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with NECA and manufacturer's instructions.

B. Load external vibration isolator such that no direct transformer unit metal is in direct contact with mounting surface.

C. Provide moisture-proof, flexible conduit for electrical connections.

D. Connect voltage taps to achieve (approximately) rated output voltage under normal plant load conditions.

E. Provide wall brackets for single-phase units, 15 kVA to 167-1/2 kVA, and three-phase units, 15 kVA to 112 kVA.

END OF SECTION

SECTION 26 23 00
LOW-VOLTAGE SWITCHGEAR

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 new draw-out circuit breaker into an existing G.E. AKD-8 switchgear line-up. Work shall include any and all materials and labor necessary to prepare an empty cubicle space to receive the breaker.

1.02 REFERENCES

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

1. American National Standards Institute (ANSI): C37.50, Switchgear—Low-Voltage AC Power Circuit Breakers Used in Enclosures—Test Procedures.
2. Institute of Electrical and Electronics Engineers (IEEE):
   a. C37.13, Standard for Low-Voltage AC Power Circuit Breakers Used in Enclosures.
   b. C37.16, Standard for Preferred Ratings, Related Requirements, and Application Recommendation for Low-Voltage AC (635V and below) and DC (3200V and below) Power Circuit Breakers.
   c. C37.20.1, Standard for Metal-Enclosed Low-Voltage Power Circuit Breaker Switchgear.
   d. C37.20.3, Standard for Metal Enclosed Interrupter Switchgear.
   e. C37.100, Standard Definitions for Power Switchgear.
3. National Electrical Manufacturers Association (NEMA): 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
4. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC).
5. Underwriters Laboratories, Inc. (UL):
   a. 489, Standard for Safety for Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit-Breaker Enclosures.
   b. 1558, Standard for Safety for Metal-Enclosed, Low-Voltage Power Circuit Breaker Switchgear.

1.03 SUBMITTALS

A. Action Submittals:

1. Descriptive product information.
2. Itemized Bill of Material.
3. Dimensional drawings.

4. Operational description.
5. One-line, three-line, and control schematic drawings.
6. Connection and interconnection drawings.
7. Circuit Breakers: Copies of time-current characteristics.
8. Ground Fault Protection: Relay time-current characteristics.
9. Bus data.

B. Informational Submittals:

1. Operation and Maintenance Data: As specified in Section 01 78 23, Operation and Maintenance Data.
2. Manufacturer's Certificate of Proper Installation, in accordance with Section 01 43 33, Manufacturers' Field Services.

1.04 QUALITY ASSURANCE

A. 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.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Materials, equipment, and accessories specified in this section shall be products of:

1. General Electric.

2.02 GENERAL REQUIREMENTS

A. Service: 480Y/277 volts, three-phase, four-wire solid grounded wye having an available short circuit current at line terminals of 65,000 amperes rms symmetrical.

B. Designed and assembled in accordance with IEEE C37.20.3, IEEE C37.100, ANSI C37.50, and UL 1558.

C. Switchgear and its major components shall be end products of one manufacturer in order to achieve standardization for appearance, operation and maintenance, spare parts replacement, and manufacturer's services.

D. Operating Conditions:

1. Ambient Temperature: Maximum 40 degrees C.
2. Equipment shall be fully rated without derating for operating conditions.

E. Lifting lugs on equipment and devices weighing over 100 pounds.

2.03 PROTECTIVE DEVICES

A. Power Air Circuit Breakers:

1. Feeder breakers in accordance with IEEE C37.13 and IEEE C37.16.
2. Arrangement: Fully rated as shown.
3. Three-pole electrically and mechanically trip-free with:
   a. Self-aligning primary and secondary contacts.
   b. Integral, solid state, over-current trip programmer.
   c. Arc quenchers.
   d. Closing Mechanism: Manual.
   e. Stored energy mechanism with maximum five-cycle closing.
   f. Solid state trip device.
4. Individually mounted, drawout breaker listed for 100 percent continuous ampere rating.
5. Frame Size: Amperes as indicated.
6. Interrupting Rating: 65,000 amperes rms symmetrical at 480 volts.

B. Mechanical Operation:

1. Front mounted, spring charging handle.
2. Mechanical closing escutcheon mounted pushbutton.
3. Mechanical trip, escutcheon mounted, trip pushbutton handle.

C. Color-Coded Visual Indicators: Contacts OPEN and CLOSED, plus mechanism CHARGED and DISCHARGED.

D. Test Facilities:

1. Breakers with integral external test points for portable test kit.
2. Handheld test kit for functional testing of trip circuitry of each breaker.

E. Solid State Trip Units: Flux-shift trip and current sensors.

1. Protective Programmers:
   a. Self-powered, automatic rms sensing micro-electronic processor.
   b. No external relays or accessories.
   c. Printed circuit cards with gold-plated contacts.
   d. Programmable Controls:
      1) Fixed-point, with repetitive accuracy and precise unit settings.
      2) Trip adjustments made by nonremovable, discrete step switching.
   e. Field-Installable Rating Plugs:
      1) Long-time pickup LED indicator and test receptacle.
      2) Matching load and cable requirements.
      3) Interlocked with tripping mechanism.
      4) Breaker to remain trip-free with plug removed.
      5) Keyed rating plugs to prevent incorrect application.
   f. Long-time pickup light.
   g. Selective coordination time/current curve shaping adjustable functions:
      1) Current setting.
      2) Long-time pickup.
      3) Long-time delay.
      4) Instantaneous pickup.
      5) Short-time pickup.
      6) Short-time delay with I2T function, and IN-OUT switch.
      7) Ground fault pickup.
      8) Ground fault delay with I2T function.
   h. Fault Trip Indicators: Mechanical push-to-reset type for overload and short circuit overload plus ground fault trip.
   i. Rejection Pins: For each programmer frame size.
2. Phase Current Sensors:
   a. Single-ratio type.
   b. Fixed, mounted on breaker frame.
   c. Molded epoxy construction.
   d. One toroidal type for each phase.
3. Ground Fault Sensor:
   a. Neutral bar single-ratio CT mounted in cable compartment.
   b. Molded epoxy construction.
   c. Shorting bar.

2.04 CONTROL WIRING

A. NFPA 70, Type SIS, single-conductor, Class B, stranded copper, rated 600 volts for control, instrumentation, and power/current circuits.

B. Shielded cable rated 600 volts for transducer output and analog circuits.

C. Enclosed in top and vertical steel wiring troughs, and front-to-rear in nonmetallic wiring troughs.

D. Conductor Lugs: Preinsulated, self-locking, spade type, with reinforced sleeves.

E. Identification: Individually, with permanent wire markers at each end.

F. Splices: Not permitted in switchgear wiring.

2.05 TERMINAL BLOCKS

A. Enclosed in steel wiring troughs.

B. Rated 600 volts, 30 amperes minimum, one-piece barrier type with strap screws.

C. Shorting type for current transformer leads.

D. Provide terminal blocks for:

1. Conductors connecting to circuits external to switchgear.
2. Internal circuits crossing shipping splits.
3. Equipment parts requiring replacement and maintenance.

E. Spare Terminals: Not less than 20 percent.

F. Group terminal blocks for external circuit wiring leads.

G. Maintain 6-inch minimum space between columns of terminal blocks.

H. Identification: Permanent, for each terminal and columns of terminals blocks.

I. Manufacturer: General Electric; Type EB-5.

2.06 TEST FACILITIES

A. Breakers with integral external test points for portable test kit.

B. Handheld test kit for functional testing of trip circuitry of each breaker.

2.07 EQUIPMENT IDENTIFICATION

A. Nameplate:

1. Engraved, acrylic for each circuit breaker cubicle and door-mounted device.
2. White with black block type characters.
3. Character Height: 3/16-inch.
4. Size: Manufacturer’s standard.
5. Inscriptions: As shown on one-line diagram.
6. Blank plates for future spaces.
7. Attachment Screws: Self-tapping.

2.08 FACTORY TESTING

A. In accordance with IEEE C37.20.1.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install equipment in accordance with manufacturer’s instructions and recommendations.

B. Secure equipment to mounting pads with anchor bolts.

C. Install equipment plumb and in longitudinal alignment with pad or wall.

D. Coordinate terminal connections with installation of secondary feeders.

3.02 MANUFACTURER’S SERVICES

A. Provide Manufacturer’s Certificate of Proper Installation in accordance with Section 01 43 33, Manufacturers’ Services.

END OF SECTION

SECTION 26 24 16
PANELBOARDS

PART 1 GENERAL

1.01 REFERENCES

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

1. Institute of Electrical and Electronics Engineers (IEEE):
   a. C62.1, Surge Arresters for Alternating Current Power Circuits.
   b. C62.11, Standards for Metal-Oxide Surge Arrestors for AC Power Circuits.
2. National Electrical Contractor's Association (NECA): 407, Recommended Practice for Installing and Maintaining Panelboards.
3. National Electrical Manufacturers Association (NEMA):
   a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
   b. 289, Application Guide for Ground Fault Circuit Interrupters.
   c. AB 1, Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit-Breaker Enclosures.
   d. KS 1, Enclosed Switches.
   e. LA 1, Surge Arrestors.
   f. PB 1, Panelboards.
   g. PB 1.1, General Instructions for Proper Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less.
4. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC).
5. Underwriters Laboratories Inc. (UL):
   a. 67, Standard for Panelboards.
   b. 98, Standard for Enclosed and Dead-Front Switches.
   c. 486E, Standard for Equipment Wiring Terminals for use with Aluminum and/or Copper Conductors.
   d. 489, Standard for Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit Breaker Enclosures.
   e. 508, Standard for Industrial Control Equipment.
   f. 870, Wireways, Auxiliary Gutters and Associated Fittings.
   g. 943, Standard for Ground-Fault Circuit-Interrupters.

1.02 SUBMITTALS

A. Action Submittals:

1. Manufacturer's data sheets for each type of panelboard, protective device, accessory item, and component.
2. Manufacturer's shop drawings including dimensioned plan, section, and elevation for each panelboard type, enclosure, and general arrangement.

3. Tabulation of features for each panelboard to include the following:
   a. Protective devices with factory settings.
   b. Provisions for future protective devices.
   c. Space for future protective devices.
   d. Voltage, frequency, and phase ratings.
   e. Enclosure type.
   f. Bus and terminal bar configurations and current ratings.
   g. Provisions for circuit terminations with wire range.
   h. Short circuit current rating of assembled panelboard at system voltage.
   i. Features, characteristics, ratings, and factory settings of auxiliary components.
   j. Seismic anchorage and bracing drawings and cut sheets, as required by Section 01 88 15, Anchorage and Bracing.

B. Informational Submittals:

1. Seismic anchorage and bracing calculations as required by Section 01 88 15, Anchorage and Bracing.
2. Manufacturer's recommended installation instructions.
3. Component and attachment testing seismic certificate of compliance as required by Section 01 45 33, Special Inspection, Observation, and Testing.

1.03 QUALITY ASSURANCE

A. Listing and Labeling: Provide products specified in this section that are listed and labeled as defined in NEC Article 100.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Materials, equipment, and accessories specified in this section shall be products of:

1. Eaton/Cutler-Hammer.
2. General Electric Co.
3. Square D Co.

2.02 GENERAL

A. Provide low voltage panelboards for application at 600V or less in accordance with this section.

B. Provide equipment in accordance with NEMA PB 1, NFPA 70, and UL 67.

C. Wire Terminations:

1. Panelboard assemblies, including protective devices, shall be suitable for use with 75 degrees C or greater wire insulation systems at NEC 75 degrees C conductor ampacity.
2. In accordance with UL 486E.

D. Load Current Ratings: Unless otherwise indicated, load current ratings for panelboard assemblies, including bus and circuit breakers, are noncontinuous as defined by NEC. Continuous ratings shall be 80 percent of noncontinuous rating.

E. Short Circuit Current Rating (SCCR): Integrated equipment short circuit rating for each panelboard assembly shall be no less than the indicated SCCR, but no less than the following:

1. Minimum SCCR at 208Y/120 or 120/240 volts shall be 10,000 amperes rms symmetrical.
2. Minimum SCCR at 480Y/277 volts shall be 30,000 amperes rms symmetrical.

F. Overcurrent Protective Devices:

1. In accordance with NEMA AB 1, NEMA KS 1, UL 98, and UL 489.
2. Protective devices shall be adapted to panelboard installation.
    a. Capable of device replacement without disturbing adjacent devices and without removing main bus.
    b. Spaces: Cover openings with easily removable cover.
3. Series-Connected Short Circuit Ratings: Devices shall be fully rated; series-connected ratings unacceptable.

G. Circuit Breakers:

1. General: Thermal-magnetic unless otherwise indicated, quick-make, quick-break, molded case, of indicating type showing ON/OFF and TRIPPED positions of operating handle.
2. Noninterchangeable: In accordance with NEC.
3. Bus Connection: Bolt-on circuit breakers in 480Y/277-volt, and plug-in circuit breakers in 208Y/120 and 240/120-volt branch circuit panelboards.
4. Trip Mechanism:
    a. Individual permanent thermal and magnetic trip elements in each pole.
    b. Variable magnetic trip elements with a single continuous adjustment 3X to 10X for frames greater than 100 amps.
    c. Two and three pole, common trip.

d. Automatically opens all poles when overcurrent occurs on one pole.
e. Test button on cover.
f. Calibrated for 40 degrees C ambient, unless shown otherwise.

5. Unacceptable Substitution:
   a. Do not substitute single-pole circuit breakers with handle ties for multi-pole breakers.
   b. Do not use tandem or dual circuit breakers in normal single-pole spaces.
6. Ground Fault Circuit Interrupter (GFCI): Where indicated, equip breaker as specified above with ground fault sensor and rated to trip on 5-mA ground fault within 0.025 second (UL 943, Class A sensitivity, for protection of personnel).
   a. Ground fault sensor shall be rated same as circuit breaker.
   b. Push-to-test button.
   c. Reset button.
7. Equipment Ground Fault Interrupter (EGFI): Where indicated, equip breaker specified above with ground fault sensor and rated to trip on 30-mA ground fault (UL listed for equipment ground fault protection).

H. Enclosures:

1. Provide as specified in Section 26 05 04, Basic Electrical Materials and Methods.
2. Material: Type 1, Type 3R, and Type 3S shall be code-gauge, hot-dip galvanized sheet steel with reinforced steel frame.
3. Finish: Rust inhibitor prime followed by manufacturer's standard gray baked enamel or lacquer.

I. Bus:

1. Material: Copper or tin-plated aluminum, full sized throughout length. Provide bolted connections with Belleville washers where aluminum bus is provided.
2. Provide for mounting of future protective devices along full length of bus regardless of number of units and spaces shown. Machine, drill, and tap as required for current and future positions.

J. Feeder Lugs: Main, feed-through, and neutral shall be replaceable, bolted mechanical or crimp compression type.

K. Equipment Ground Terminal Bus: Copper with suitably sized provisions for termination of ground conductors, and bonded to box.

1. Provide individual mechanical termination points no less than the quantity of breaker pole positions.

2. Provide individual termination points for all other grounding conductors such as feeder, grounding electrode, etc.
3. Termination points shall be bolted crimp compression lugs for conductors 6 AWG and larger.

L. Neutral Terminal Bus: Copper with suitably sized provisions for termination of neutral conductors, and isolated from box.

1. Provide individual mechanical termination points no less than the quantity of breaker pole positions.
2. Provide individual termination points for all other neutral conductors.
3. Termination points shall be bolted crimp compression lugs for conductors 6 AWG and larger.

M. Provision for Future Devices: Equip with mounting brackets, bus connections, and necessary appurtenances for future protective device ampere ratings indicated.

N. Special Features: Where indicated, provide the following features:

1. Surge Protective Devices:
   a. Surge protective devices (SPD) and all components shall be designed, manufactured, tested, and listed in accordance with the latest edition of ANSI/UL 1449 3rd Edition.
   b. UL Designation: Type 2.
   c. Electrical Requirements:
      1) Maximum Continuous Operating Voltage: Not less than 115 percent of the nominal system voltage.
      2) Protection Modes: Protect all modes (L-L, L-N, etc.) of the electrical system being utilized with a minimum of seven mode protection.
      3) Nominal Discharge Current (I_n): 20 kA.
      4) Voltage Protection Rating (VPR) shall not exceed the following:

Voltage Rating	L-N	L-G	N-G	L-L
208Y/120-240	700	700	700	1,200
480Y/277	700	700	700	2,000
240Δ	n/a	1,500	n/a	3,000
480Δ	n/a	1,500	n/a	2,000

      5) Surge Current Capacity: ANSI/IEEE C62.41 Category C; 80kA per phase, 40 kA per mode.
      6) EMI/RFI Noise Suppression: Minus 50 dB attenuation at 100 kHz tested in accordance with MIL-STD 220B.

d. SPD Design:
   1) Unit shall incorporate thermally protected metal-oxide varistors (MOVs).
   2) All internal components shall be hardwired and soldered; no plug-in modules are permitted.
   3) Provide LED status for each protected phase, a form C dry contact for remote status indication, and a surge event counter.
   4) SPD shall be mounted integral to the electrical distribution equipment.

2.03 LIGHTING AND APPLIANCE BRANCH CIRCUIT PANELBOARDS

A. Protective Device Locking: Furnish provisions for handle padlocking for main and subfeed devices; also provide for branch devices where indicated.

B. Multi-Section Panelboards: Where more than 42 poles are required or more than one section is otherwise indicated, provide multiple panelboards with separate fronts.

1. Panelboard sections shall be individually installed and field interconnected to form a single electrical unit.
2. Unless otherwise indicated, provide feed-through lugs on each section but last.
3. Surface-mount panels shall be individually mounted and may be different sizes.
4. Recessed-mount panels shall be individually mounted and the same size tub and flush cover.
5. Surface-mount multi-section panelboards may be comprised of sections of unequal heights.
6. Provide feed-through and main lugs in individual sections as required for field assembly of a complete multi-section panelboard.
7. Provide neutral and ground terminal bars in each section.

C. NEMA 250 Type 1 Branch Panelboard Enclosure:

1. Front trim shall be secured to box with concealed trim clamps.
2. Surface-mount panelboard front trim shall have same dimensions as box.
3. Flush panelboards front trims shall overlap box nominal 3/4 inch on all sides.
4. Door in panelboard front trim, with concealed hinges, shall provide access to protective device operating handles.
5. Doors over 30 inches in height shall have multi-point latching.
6. Door lock shall be secure with flush catch and tumbler lock; all panelboards keyed alike, with two milled keys each lock.

7. Circuit Directory: Metal frame with transparent plastic face and enclosed card, mounted inside each panel door.
8. Hinged Front Cover (Door-in-Door): Entire front trim hinged to surface box with standard door within hinged trim cover.

PART 3 EXECUTION

3.01 GENERAL

A. Install in accordance with NECA 407, NEMA PB 1.1 and manufacturers' written installation instructions.

B. Install securely, plumb, in-line and square with walls.

C. Install top of cabinet trim78 inches above floor, unless otherwise shown. Install cabinet so tops of protective device operating handles are no more than 78 inches above the floor.

D. Ground Fault Protection: Install panelboard ground fault circuit interrupter devices in accordance with installation guidelines of NEMA 289.

E. Install filler plates in unused spaces.

F. Wiring in Panel Gutters: Train conductors neatly in groups; bundle, and wrap with nylon wire ties.

3.02 BRANCH CIRCUIT PANELBOARD

A. Mount flush panels uniformly flush with wall finish.

B. Provide typewritten circuit directory for each panelboard.

3.03 POWER DISTRIBUTION PANELBOARD

A. Provide engraved identification for each protective device.

END OF SECTION

SECTION 26 24 19
LOW-VOLTAGE MOTOR CONTROL

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which shall be followed for this section:

1. Institute of Electrical and Electronics Engineers (IEEE): C2, National Electrical Safety Code (NESC).
2. National Electrical Contractors Association (NECA): 402, Standard for Installing and Maintaining Motor Control Centers.
3. National Electrical Manufacturers Association (NEMA):
   a. 250, Enclosures for Electrical Equipment (1,000 volts maximum).
   b. ICS 1, Industrial Control and Systems: General Requirements.
   c. ICS 2, Controllers, Contactors, and Overload Relays Rated 600 Volts.
   d. ICS 2.3, Instructions for the Handling, Installation, Operation, and Maintenance of Motor Control Centers Rated Not More Than 600V.
   e. ICS 18, Motor Control Centers.
   f. KS 1, Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum).
4. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC).
5. Underwriters Laboratories, Inc. (UL):
   a. 98, Enclosed and Dead-Front Switches.
   b. 489, Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit Breaker Enclosures.
   c. 845, Motor Control Centers.

1.02 DEFINITIONS

A. CT: Current transformer.

B. LCD: Liquid crystal display.

C. N.C.: Normally closed.

D. N.O.: Normally open.

E. THD: Total harmonic distortion.

F. VT: Voltage transformer.

1.03 SUBMITTALS

A. Action Submittals:

1. Descriptive information.
2. Itemized bill of material.
3. Dimensional drawings.
4. Front panel elevations.
5. Conduit entrance locations.
6. Bus data.
7. Protective Devices: Copies of time-current characteristics.
8. Anchoring instructions and details.
9. Typed Tabulation:
    a. Motor name; tag (equipment) numbers as shown on Drawings.
    b. Motor horsepower.
    c. Nameplate full load current.
    d. Measured load current and voltage.
    e. Heater model number and relay setting.
    f. Protective device trip settings.
    g. Manufacturer's solid state starter switch or dip switch or program settings.
    h. Attach above typed, tabulated data to a copy of starter manufacturer's overload heater or setting selection tables for starters provided.
10. Control diagrams.
11. One-line diagrams.
12. Schematic (elementary) diagrams.
13. Outline diagrams.

B. Informational Submittals:

1. Manufacturer's installation instructions.
2. Factory test reports, certified.
3. Operation and Maintenance Data as specified in Section 01 78 23, Operation and Maintenance Data.

1.04 QUALITY ASSURANCE

A. Provide products manufactured within scope of Underwriters Laboratories that conform to UL Standards and have applied UL Listing Mark.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Shipping Splits: Established by Contractor to facilitate ingress of equipment to final installation location within building.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Materials, equipment, and accessories specified in this section shall be products of:

1. Eaton Electrical/Cutler-Hammer.
2. GE Industrial Systems.
3. Schneider Electric/Square D Services.
4. Allen-Bradley.

2.02 GENERAL

A. Like Items of Equipment: End product of one manufacturer.

B. Make adjustments necessary to wiring, conduit, disconnect devices, motor starters, branch circuit protection, and other affected material or equipment to accommodate motors actually provided under this Contract.

C. Controllers: NEMA ICS 1, NEMA ICS 2, Class A.

D. Control Transformer:

1. Two winding, 120-volt secondary, primary voltage to suit.
2. Two current-limiting fuses for primary circuit.
3. One fuse in secondary circuit with blown fuse indicator.
4. Mount within starter unit.

E. Suitable for use with 75 degrees C wire at full NFPA 70, 75 degrees C ampacity.

F. Lifting lugs on equipment and devices weighing over 100 pounds.

G. Anchor Bolts: Type 316 stainless steel, 1/2-inch minimum diameter, and as specified in Section 05 50 00, Metal Fabrications.

H. Seismic Zone and Importance Factor shall be as specified in Section 01 61 00, Common Product Requirements.

I. Operating Conditions:

1. Ambient Temperature: Maximum 40 degrees C.
2. Altitude: 1,000 feet above sea level.
3. Equipment to be fully rated.

J. Enclosures: In accordance with NEMA 250.

K. Equipment Finish:

1. Electrocoating process applied over rust-inhibiting phosphated base coating.
2. Exterior Color: Manufacturer's standard.

2.03 MOTOR CONTROL CENTERS

A. General:

1. In accordance with NEMA ICS 1, NEMA ICS 2, NEMA ICS 18, and UL 845.
2. Voltage Rating: As shown.
3. Short Circuit Rating: 65,000 amperes rms symmetrical at 480 volts for entire motor control center as a complete assembly.
4. Main and branch circuit breakers, controllers, wire connections, and other devices to be front mounted and accessible, unless otherwise noted.
5. NEMA ICS 18, Part 3.
   a. Class: I.
   b. Type: B.

B. Enclosure:

1. Type: NEMA 250 Type 1, indoor gasketed.
2. Vertical Section Standard Indoor Dimensions for NEMA 1 Type:
   a. Nominal, 90 inches high, 20 inches wide, 21 inches deep.
   b. Alternative width dimensions of 24 inches and 30 inches are acceptable for oversize devices or panels.
   c. Do not exceed space shown.
3. Construction:
   a. Sheet steel reinforced with channel or angle irons.
   b. Butt sections flush, end-to-end against similar section without bolts, nuts, or cover plates causing interference.
   c. Removable top cover plates and bottom cover plates.
   d. Removable plates on end panels for future bus extension.
4. Section Mounting: Removable formed-steel channel sills and lifting angles.
5. Horizontal Wiring Compartments: Accessible from front, full width, top and bottom.
6. Vertical Wiring Compartment:
   a. Full height, isolated from unit starters with separate hinged door and tie supports.
   b. No terminal blocks allowed in vertical wireway compartment.
   c. Provide separate low level signal raceway in wireway.

7. Unit Compartment: Individual compartments separated by steel barriers for each starter, feeder, or other unit capable of being wired from front without unit removal.
8. Compartment Doors: Separate hinged doors for each starter, feeder, or other unit.
9. Door Interlocking: Mechanically interlock starter and feeder doors so doors cannot be opened with unit energized. Provide defeater mechanism to allow intentional access and energizing at any time by qualified individual.
10. External disconnect handles with ON/OFF and trip positions showing, padlockable in OFF position with up to three-lock capability.
11. Cable Entrance: Main leads enter from top; control and feeder circuits enter from top.

C. Bus:

1. Horizontal Power Bus:
   a. Three-phase tin-plated, copper, entire width of control center, rated as shown.
   b. Tin or silver-plated at joints.
   c. Construct to allow future extension of additional sections.
   d. Pressure type solderless lugs for each incoming line cable.
   e. Isolated from top horizontal wireway.
2. Vertical Power Bus:
   a. Three-phase tin-plated, copper, full height of section, rated 300 amperes.
   b. Tin-plated at joints.
   c. Sandwich type bus insulation providing deadfront construction with starter units removed except for bus stab openings.
   d. Insulated and isolated barrier, complete with shutters.
3. Neutral Bus: None.
4. Ground Bus:
   a. Copper, bare, rated 300 amperes, entire width of control center and in each vertical wireway.
5. Bus Bracing: 65,000 amperes rms symmetrical.

D. Motor Controller Unit:

1. Provide indicated individual components and control devices including pushbuttons, selector switches, indicating lights, control relays, time delay relays, and elapsed time meters as specified in Section 26 05 04, Basic Electrical Materials and Methods.
2. Construction:
   a. Drawout combination type with stab connections for starters NEMA ICS, Size 5 and smaller.

b. Bolt-on combination type with cable connection to riser for starters NEMA ICS, Size 6 and larger.
c. Readily interchangeable with starters of similar size.
d. Pull-apart unit control wiring terminal boards capable of accepting up to two No. 14 AWG wires minimum on all units.

3. Starters:
   a. NEMA ICS 18, standard rating, except none smaller than NEMA ICS, Size 1.
   b. Rating: Horsepower rated at 600 volt, UL labeled for 65,000 amperes at 480 volts short circuit capacity with overload protection.
   c. Three-phase, nonreversing, unless specified otherwise.
   d. Disconnect Type: Motor circuit protector.
   e. Combination Full Voltage, Magnetic Starter:
      1) Control: As shown on Drawings.
      2) Pilot Lights: Red–ON and Green–OFF.
   f. Combination Reduced Voltage, Solid State Starter:
      1) Control: As shown on Drawings.
      2) Integral shorting-type bypass contactor.
      3) Class 10/20/30 electronic overload relay, switch, or dip switch selectable.
      4) Kick start, with adjustable torque and time settings.
      5) Ramp start, selectable current or torque, and adjustable time.
      6) Smooth stop ramp, adjustable time.
      7) Phase loss unbalance and phase reversal protection.
      8) LED display or LCD of fault, N.O. contact to communicate fault condition.
   g. Combination Reversing, Magnetic Starter:
      1) Control: As shown on Drawings.
      2) Suitable for squirrel cage motors.
      3) Pilot Lights: Green–OFF, Red–FORWARD, Amber–REVERSE.
   h. Combination Adjustable Frequency Drive, Solid State Starter: Drives as specified in Section 26 29 23, Low-Voltage Adjustable Frequency Drive System.
   i. Communications: None.
   j. Padlockable operating handle when de-energized with up to three-lock capability.
   k. Unit door interlocked to prevent opening when disconnect is in closed position.
   l. Mechanical interlocked to prevent placing disconnect in ON position when unit door is open.
   m. Minimum Dimensions: 12 inches high by full section width, less vertical wireway.
4. Disconnecting Device: Padlockable in OPEN position for up to three locks.

5. Circuit Breaker:
    a. Meet requirements of UL 489.
    b. Molded case with manufacturer's recommended trip setting for maximum motor protection.
    c. Thermal-magnetic trip or magnetic trip only as shown.
    d. Tripping indicated by operating-handle position.
    e. Interrupting capacity required for connection to system with short-circuit capacity indicated.
6. Solid State Motor Overload Protection:
    a. Inverse-time-limit characteristic.
    b. Phase loss, phase unbalance and Class II ground fault protection.
    c. Current operated electronic circuitry with adjustable trip.
    d. Class 10/20/30 relay trip, switch selectable.
    e. One N.O. auxiliary contact for remote monitoring.
    f. Manual reset.
    g. Provide in each ungrounded phase.
    h. Mount within starter unit.
    i. Communications: None.

E. Control Unit:

1. Disconnecting Device: Pull-apart terminal blocks capable of de-energizing external source control circuits in unit.
2. Control Devices: As indicated and as specified in Section 26 05 04, Basic Electrical Materials and Methods.
3. Control Wiring:
    a. Copper, 14 AWG, minimum.
    b. Permanent sleeve type markers with wire numbers applied to each end of wires.
    c. Terminate wires using insulated locking fork or ring type crimp terminals.
    d. Terminate current transformer leads on shorting type terminal blocks.

F. Incoming Line Terminal:

1. Construction: As specified in Paragraph, Motor Controller Unit.
2. Incoming Service Feeder: Cable.
3. Mechanical type CU-/AL lugs for 75 degrees C cable.

G. Surge Protective Devices:

1. Surge protective devices (SPD) and all components shall be designed, manufactured, tested, and listed in accordance with the latest edition of ANSI/UL 1449 3r^{d} Edition.
2. UL Designation: Type 2.

3. Electrical Requirements:
   a. Maximum Continuous Operating Voltage: Not less than 115% of the nominal system voltage.
   b. Protection Modes: Protect all modes (L-L, L-N, etc.) of the electrical system being utilized with a minimum of seven mode protection.
   c. Nominal Discharge Current (I_n): 20kA.
   d. Voltage protection rating (VPR) shall not exceed the following:

Voltage Rating	L-N	L-G	N-G	L-L
208Y/120-240	700	700	700	1,200
480Y/277	700	700	700	2,000
240Δ	n/a	1,500	n/a	3,000
480Δ	n/a	1,500	n/a	2,000

   e. Surge Current Capacity: ANSI/IEEE C62.41 Category C; 160 kA per phase, 80 kA per mode.
   f. EMI/RFI noise suppression: Minus 50 dB attenuation at 100 kHz tested in accordance with MIL-STD 220B.
4. SPD Design:
   a. Unit shall incorporate thermally protected metal-oxide varistors (MOVs).
   b. All internal components shall be hardwired and soldered; no plug-in modules are permitted.
   c. Provide LED status for each protected phase, a form C dry contact for remote status indication, and a surge event counter.
   d. SPD shall be mounted integral to the electrical distribution equipment.

H. Pushbuttons, Indicating Lights, Selector Switches, Elapsed Time Meters, Control Relays, Time-Delay Relays, and Reset Timers: As specified in Section 26 05 04, Basic Electrical Materials and Methods.

I. Nameplates:

1. Laminated plastic; white, engraved to black core.
2. Provide for each motor control center and each unit.
3. Engrave with inscription shown on single-line diagram.
4. Provide blank nameplates on spaces for future units.
5. Attach with stainless steel panhead screws on face of control center.

2.04 SOURCE QUALITY CONTROL

A. Factory Testing:

1. Applicable Standards: NEMA ICS 18, UL 845, and NEC Article 430, Part VIII.
2. Perform standard factory inspection and tests in accordance with NEMA requirements to verify components have been designed to Specification, assembled in accordance with applicable standards, and each unit functions in accordance with electrical diagrams.
3. Actual operation shall be performed wherever possible. Otherwise, inspect and perform continuity checks.
4. Verify component devices operated correctly in circuits as shown on diagrams or as called for in Specification.
5. Control Circuits and Devices:
   a. Energize circuit at rated voltage.
   b. Operate control devices.
   c. Perform continuity check.
6. Instruments, Meters, Protective Relays, and Equipment:
   a. Verify devices functioned by energizing potential to rated values with connection to devices made at outgoing terminal blocks.
   b. Verify protective relays operated for functional checks and trips manually initiated to verify functioning of operation for indicator and associated circuits.
7. Perform dielectric tests on primary circuits and equipment, except potential transformers. Tests shall be made phase-to-phase and phase-to-around with 60-cycle test voltages applied for 1 second at 2,640 volts.
8. Verify equipment passed tests and inspection.
9. Provide standard factory inspection and test checklists, and final certified and signed test report.

PART 3 EXECUTION

3.01 INSTALLATION

A. General:

1. Install equipment in accordance with NEMA ICS 2.3, IEEE C2, NECA 402, Submittals, and manufacturer’s written instructions and recommendations.
2. Secure equipment to mounting pads with anchor bolts of sufficient size and number adequate for specified seismic conditions.
3. Install equipment plumb and in longitudinal alignment with pad or wall.
4. Coordinate terminal connections with installation of secondary feeders.
5. Grout mounting channels into floor or mounting pads.

6. Retighten current-carrying bolted connections and enclosure support framing and panels to manufacturer's recommendations.
7. Motor Data: Provide typed, self-adhesive label attached inside each motor starter enclosure door displaying the following information:
    a. Motor served by tag number and equipment name.
    b. Nameplate horsepower.
    c. Motor code letter.
    d. Full load amperes.
    e. Service factor.
    f. Installed overload relay heater catalog number.

B. Circuit Breakers:

1. Field adjust trip settings of motor starter magnetic-trip-only circuit breakers.
2. Adjust to approximately 11 times motor rated current.
3. Determine motor rated current from motor nameplate following installation.

C. Overload Relay: Select and install overload relay heaters and switch settings after actual nameplate full-load current rating of motor has been determined.

END OF SECTION

SECTION 26 27 26
WIRING DEVICES

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): A167, Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.
2. Federal Specifications (FS):
   a. W-C-596G, General Specification for Connector, Electrical, Power.
   b. W-S-896F, Switches, Toggle (Toggle and Lock), Flush Mounted (General Specification).
3. Institute of Electrical and Electronic Engineers, Inc. (IEEE):
   a. C62.41.2, Recommended Practice on Characterization of Surges in Low-Voltage (1000V and less) AC Power Circuits.
   b. C62.45, Recommended Practice on Surge Testing for Equipment Connected to Low-Voltage (1000V and less) AC Power Circuits.
4. National Electrical Contractors Association (NECA): 1, Standard Practice of Good Workmanship in Electrical Contracting.
5. National Electrical Manufacturers Association (NEMA):
   a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
   b. FB 11, Plugs, Receptacles, and Connectors of the Pin and Sleeve Type for Hazardous Locations.
   c. WD 1, General Color Requirements for Wiring Devices.
   d. WD 6, Wiring Devices – Dimensional Specifications.
6. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC).
7. Underwriters Laboratories Inc. (UL):
   a. 498, Standard for Safety for Attachment Plugs and Receptacles.
   b. 508, Standard for Safety for Industrial Control Equipment.
   c. 943, Standard for Safety for Ground-Fault Circuit-Interrupters.
   d. 1010, Standard for Safety for Receptacle-Plug Combinations for Use in Hazardous (Classified) Locations.
   e. 1436, Standard for Safety for Outlet Circuit Testers and Similar Indicating Devices.
   f. 1449, Standard for Safety for Surge Protective Devices (SPD).

1.02 SUBMITTALS

A. Action Submittals: Manufacturer’s product data for wiring devices.

PART 2 PRODUCTS

2.01 SWITCHES

A. Switch, General Purpose:

1. NEMA WD 1 and FS W-S-896F.
2. Totally enclosed, ac type, with quiet tumbler switch and screw terminal.
3. Rivetless one-piece brass or copper alloy contact arm with silver alloy contact.
4. Capable of controlling 100 percent tungsten filament and fluorescent lamp loads.
5. Rating: 20 amps, 120/277 volts.
6. Automatic grounding clip and integral grounding terminal on mounting strap.
7. Special Features: Provide the following features in comparable devices where indicated.
   a. Three-way and four-way.
8. Manufacturers and Products, Industrial Grade:
   a. Cooper Arrow Hart; AH1220 Series.
   b. Bryant; 4901 Series.
   c. Hubbell; 1221 Series.
   d. Leviton; 1221 Series.

B. Switch, Motor Rated:

1. Type: Two-pole or three-pole, manual motor starting/disconnect switch without overload protection.
2. UL 508 listed.
3. Totally enclosed snap-action switch. Quick-make, slow-break design with silver alloy contacts.
4. Minimum General Purpose Rating: 30 amperes, 600V ac.
5. Minimum Motor Ratings:
   a. 2 horsepower for 120V ac, single-phase, two-pole.
   b. 3 horsepower for 240V ac, single-phase, two-pole.
   c. 15 horsepower for 480V ac, three-phase, three-pole.
6. Screw-type terminal.
7. Manufacturers and Products:
   a. Cooper Arrow Hart.
   b. Hubbell Bryant: HBL78 Series.
   c. Leviton.

2.02 RECEPTACLES

A. Receptacle, General Purpose:

1. NEMA WD 1 and FS W-C-596G.
2. Duplex, two-pole, three-wire grounding type with screw type wire terminals.
3. Impact resistant nylon cover and body, with finder grooves in face, unless otherwise indicated.
4. One-piece mounting strap with integral ground contact (rivetless construction).
5. Contact Arrangement: Contact to be made on two sides of each inserted blade without detent.
6. Rating: 125 volts, NEMA WD 1, Configuration 5-20R, 20 amps, unless otherwise indicated.
7. Size: For 2-inch by 4-inch outlet box.
8. Special Features: Provide the following features in comparable devices where indicated:
    a. Listed weather-resistant in accordance with NEC 406.8.
9. Industrial Grade Manufacturers and Products:
    a. Cooper Arrow Hart; 5362 Series.
    b. Hubbell Bryant; HBL5362 Series.
    c. Leviton; 5362 Series.

B. Receptacle, Ground Fault Circuit Interrupter:

1. Meet requirements of general-purpose receptacle.
2. Listed Class A to UL 943, tripping at 5 mA.
3. Rectangular smooth face with push-to-test and reset buttons.
4. Listed weather-resistant in accordance with NEC 406.8.
5. Feed-through Capability: 20 amps.
6. Manufacturers and Products:
    a. Hubbell Bryant; GFTR20 Series.
    b. Cooper Arrow Hart WRVGF20 Series.
    c. Leviton; 7899 Series.

C. Receptacle, Corrosion-Resistant:

1. Meet requirements of general-purpose receptacle.
2. Nickel coated metal parts.
3. Manufacturers and Products:
    a. Hubbell Bryant; HBL53CM62 Series.
    b. Leviton; 53CM-62 Series.
    c. Cooper Arrow Hart; 5362CR Series.

2.03 DEVICE PLATES

A. Sectional type plate not permitted.

B. Metal:

1. Material: Specification grade, one-piece, 0.040-inch nominal thickness stainless steel.
2. Finish: ASTM A167, Type 302/304, satin.
3. Mounting Screw: Oval-head, finish matched to plate.

C. Cast Metal:

1. Material: Copper-free aluminum.
2. Screw: Oval-head stainless steel.

D. Weatherproof:

1. Receptacle, Weatherproof Type 1:
   a. Gasketed, cast-aluminum, with individual cap over each receptacle opening.
   b. Mounting Screw and Cap Spring: Stainless steel.
   c. Manufacturers and Products:
      1) Crouse-Hinds; Type WLRD-1.
      2) Appleton; Type FSK-WRD.
2. Receptacle, Weatherproof Type 2:
   a. UL listed for wet location while in use.
   b. Die cast metal cover.
   c. Manufacturer and Product: TayMac; Type Multi-Mac.
3. Switch:
   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.

2.04 FINISHES

A. Wiring device catalog numbers specified in this section do not designate device color. Unless otherwise indicated, or required by code, provide colors as specified below.

B. Wiring Device: Gray

C. Corrosion-resistant receptacle may be manufacturer’s standard color (yellow).

PART 3 EXECUTION

3.01 INSTALLATION, GENERAL

A. Comply with NECA 1.

B. Coordination with Other Trades:

1. Ensure device and its box are protected. Do not place wall finish materials over device box and do not cut holes for box with router that is guided by riding against outside of box.
2. Keep outlet box free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate raceway system, conductors, and cables.
3. Install device box in brick or block wall such that cover plate does not cross a joint, unless otherwise indicated. Where indicated or directed to cross joint, trowel joint flush with face of wall.
4. Install wiring device after wall preparation, including painting, is complete.

C. Conductors:

1. Do not strip insulation from conductors until just before they are spliced or terminated on devices.
2. Strip insulation evenly around conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.
3. Length of free conductors at outlets for devices shall meet provisions of NFPA 70, Article 300, without pigtails.
4. Existing Conductors:
   a. Cut back and pigtail, or replace damaged conductors.
   b. Straighten conductors that remain and remove corrosion and foreign matter.
   c. Pigtailing existing conductors is permitted provided outlet box is large enough.

D. Device Installation:

1. Replace devices that have been in temporary use during construction or that show signs they were installed before building finishing operations were complete.
2. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
3. Do not remove surface protection, such as plastic film and smudge covers, until last possible moment.
4. Connect devices to branch circuits using pigtails that are not less than 6 inches (150 mm) in length.

5. Use torque screwdriver when a torque is recommended or required by manufacturer.
6. When conductors larger than 12 AWG are installed on 15-amp or 20-amp circuits, splice 12 AWG pigtails for device connections.
7. Tighten unused terminal screws on device.
8. Device Plates:
    a. Do not use oversized or extra deep plate.
    b. Repair wall finishes and remount outlet box when standard device plate does not fit flush or does not cover rough wall opening.

3.02 SWITCH INSTALLATION

A. Switch, General Purpose:

1. Mounting Height: See Section 26 05 33, Raceway and Boxes.
2. Install with switch operation in vertical position.
3. Install single-pole, two-way switch such that toggle is in up position when switch is on.

B. Switch, Motor Rated:

1. Mounting Height: See Section 26 05 33, Raceway and Boxes.
2. Install with switch operation in vertical position such that toggle is in up position when ON.
3. Install within sight of motor when used as disconnect switch.

C. Occupancy Sensor, Wall Switch: Install in accordance with manufacturer’s instructions.

3.03 RECEPTACLE INSTALLATION

A. Duplex Receptacle:

1. Install with grounding slot down, except where horizontal mounting is shown, in which case install with neutral slot up.
2. Ground receptacle to box with grounding wire only.
3. Weatherproof Receptacle:
    a. Install in cast metal box.
    b. Install such that hinge for protective cover is above receptacle opening.
4. Ground Fault Interrupter: Install feed-through model at locations where ground fault protection is specified for “downstream” conventional receptacles.
5. Special-Purpose Receptacle: Install in accordance with manufacturer’s instructions.

3.04 DEVICE PLATE INSTALLATION

A. Securely fasten to wiring device; ensure tight fit to box.

B. Flush-Mounted: Install with all four edges in continuous contact with finished wall surface without use of mat or similar material. Plaster fillings will not be acceptable.

C. Surface-Mounted: Plate shall not extend beyond sides of box, unless plate has no sharp corners or edges.

D. Install with alignment tolerance to box of 1/16 inch.

E. Type (Unless Otherwise Shown): Metal.

1. Exterior:
    a. Switch: Weatherproof.
    b. Receptacle in Damp Location: Weatherproof Type 1.
    c. Receptacle in Wet Location: Weatherproof Type 2.

F. Interior:

1. Flush Mounted Box: Metal.
2. Surface Mounted, Metal Box: Cast.
3. Surface Mounted, Aluminum Box: Cast.
4. Receptacle Shown as Weatherproof on Drawings: Weatherproof Type 1.

3.05 IDENTIFICATION

A. Use tape labels for identification of individual wall switches and receptacles in dry indoor locations.

1. Degrease and clean device plate surface to receive tape labels.
2. Use 3/16-inch Kroy black letters on white background, unless otherwise indicated.
3. Identify panelboard and circuit number from which item is served on face of plate.

B. Identify conductors with durable wire markers or tags inside outlet boxes.

3.06 FIELD QUALITY CONTROL

A. Perform tests and inspections, and prepare test reports.

B. Test Instrument for 125-Volt 20-Amp Receptacle: Digital wiring analyzer with digital readout or illuminated LED indicators of measurement.

C. Using test plug, verify device and its outlet box are securely mounted.

D. Line Voltage Range: 105 volts to 132 volts.

E. Percent Voltage Drop under 15-Amp Load: Less than 6 percent; 6 percent or higher is not acceptable.

F. Ground Impedance: 2 ohms, maximum.

G. GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.

H. Tests shall be diagnostic, indicating damaged conductors, high resistance at circuit breaker, poor connections, inadequate fault current path, defective devices, or similar problems. Correct circuit conditions, remove malfunctioning units and replace with new ones, and retest as specified above.

END OF SECTION

SECTION 26 50 00
LIGHTING

PART 1 GENERAL

1.01 REFERENCES

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

1. Canadian Standards Association (CSA).
2. Certified Ballast Manufacturer (CBM).
3. Federal Communications Commission (FCC).
4. Illuminating Engineering Society of North America (IESNA).
5. Institute of Electrical and Electronics Engineers (IEEE): C62.41, Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits.
6. National Electrical Manufacturers Association (NEMA): 250, Enclosures for Electrical Equipment (1,000 Volts Maximum).
7. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC) – Softbound Version.
8. Underwriters Laboratories, Inc. (UL):
   a. 595, Marine-Type Electric Lighting Fixtures.
   b. 844, Electric Lighting Fixtures for Use in Hazardous (Classified) Locations.
   c. 924, Emergency Lighting and Power Equipment.

1.02 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
   a. Interior Luminaires:
      1) Catalog data sheets and pictures.
      2) Luminaire finish and metal gauge.
      3) Lens material, pattern, and thickness.
      4) Candle power distribution curves in two or more planes.
      5) Candle power chart 0 degree to 90 degrees.
      6) Lumen output chart.
      7) Average maximum brightness data in foot lamberts.
      8) Coefficients of utilization for zonal cavity calculations.
      9) Mounting or suspension details.
   b. Exterior Luminaires:
      1) Catalog data sheets and pictures.
      2) Luminaire finish and metal gauge.
      3) Lens material, pattern, and thickness.

4) IESNA lighting classification and isolux diagram.
5) Fastening details to wall or pole.
6) Ballast type, location, and method of fastening.
7) For light poles, submit wind loading, complete dimensions, and finish.

c. Lamps:
1) Voltages.
2) Colors.
3) Approximate life (in hours).
4) Approximate initial lumens.
5) Lumen maintenance curve.
6) Lamp type and base.
7) Copy of lamp order, including individual quantities, for Project.

d. Ballasts:
1) Type.
2) Wiring diagram.
3) Nominal watts and input watts.
4) Input voltage and power factor.
5) Starting current, line current, and restrike current values.
6) Sound rating.
7) Temperature rating.
8) Efficiency ratings.
9) Low temperature characteristics.
10) Emergency ballasts rating and capacity data.

e. Seismic anchorage and bracing drawings and cut sheets, as required by Section 01 88 15, Anchorage and Bracing.

B. Informational Submittals: Seismic anchorage and bracing calculations as required by Section 01 88 15, Anchorage and Bracing.

1.03 QUALITY ASSURANCE

A. 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.

1.04 EXTRA MATERIALS

A. Furnish, tag, and box for shipment and storage the following spare parts and materials:

Item	Quantity
Spare ballast of each type	Two complete sets per fixture type
Spare lamps of each type	Two complete set per fixture type

PART 2 PRODUCTS

2.01 LUMINAIRES

A. Specific requirements relative to execution of the Work of this section are located in Luminaire Schedule on Drawings.

B. Feed-through type, or separate junction box.

C. Ballasts: Two-lamp when possible.

D. Tandem wired for three-lamp, fluorescent fixtures.

E. Wire Leads: Minimum 18 AWG.

F. Component Access: Accessible and replaceable without removing luminaire from ceiling.

G. Exterior Installations:

1. UL Labeled: SUITABLE FOR WET LOCATIONS.
2. Ballast: Removable, prewired.
3. When factory-installed photocells are provided, entire assembly shall have UL label.

H. Emergency Lighting:

1. Power Pack: Self-contained, 120/277-volt dual-voltage selectable input transformer, inverter/charger, sealed nickel cadmium battery, and indicator switch in accordance with UL 924.
2. Lighted, push-to-test indicator.
3. Capable of providing full illumination for 1-1/2 hours in emergency mode.
4. Capable of full recharge in 24 hours, automatically upon resumption of normal line voltage.
5. Capable of protecting against excess charging and discharging.

2.02 LAMPS

A. Manufacturers:

1. General Electric Co.
2. Osram Sylvania.
3. Phillips Lighting Company.

2.03 BALLASTS

A. General:

1. Meet requirements for fixture light output, reliable starting, radio interference, total harmonic distortion, electromagnetic interference, and dielectric rating.
2. Certified by electrical testing laboratory to conform to CBM specifications.

B. Fluorescent (Electronic):

1. Provide in 1 lamp, 2 lamp, or 3 lamp models.
2. High frequency ballast of 20k Hz or greater; rapid-start.
3. Meets FCC Part 18.
4. UL listed, Class P, sound rating A.
5. Power factor of 98 percent or greater.
6. Total harmonic distortion THD shall be less than 20 percent.
7. Shall withstand line transients in accordance with IEEE C62.41, Cat A.
8. Shall not contain PCBs and shall carry a minimum 3-year manufacturer’s warranty.
9. Ballast shall start lamp at a minimum temperature of 40 degrees F.

C. Metal Halide:

1. High power factor, normal ambient, 180 degrees C insulation class.
2. Types:
   a. Autotransformer with capacitor and ignitor for lamps 150 watts and less.
   b. Constant wattage autotransformer with capacitor for lamps above 150 watts.

D. High Pressure Sodium:

1. High power factor, normal ambient, 180 degrees C insulation class, with capacitor and ignitor.
2. Type:
   a. Autotransformer for 50-watt lamps.
   b. Constant wattage autotransformer for lamps 70 watts and above.

E. Manufacturers:

1. MagneTek Lighting Products.
2. Advance Transformer Co.
3. Motorola Lighting Inc.
4. SLI Inc.
5. General Electric.

2.04 POLES

A. Rating (With Luminaire): 125 mph steady winds, without incurred damage.

B. Material: Extruded aluminum.

PART 3 EXECUTION

3.01 LUMINAIRES

A. General:

1. Install in accordance with manufacturer's recommendations.
2. Provide proper hangers, pendants, and canopies as necessary for complete installation and meeting specified seismic requirements.
3. Provide additional ceiling bracing, hanger supports, and other structural reinforcements to building required to safely mount.
4. Install plumb and level.
5. Install each luminaire outlet box with galvanized stud.

B. Mounting:

1. General:
   a. Mounting, fastening, and environmental conditions shall be coordinated with Section 26 05 02, Basic Electrical Requirements.
   b. Refer to Fastener Schedule in Section 05 50 00, Metal Fabrications.
2. Wall Mounted: Measure mounting heights from center of mounting plate to finished floor or finished grade, whichever is applicable.
3. Pendant Mounted:
   a. Provide swivel type hangers and canopies to match luminaires, unless otherwise noted.
   b. Space single-stem hangers on continuous-row fluorescent luminaires nominally 48 inches apart.
   c. Provide twin-stem hangers on single luminaires.
   d. Measure mounting heights from bottom of luminaire to finished floor or finished grade, whichever is applicable.

4. Pole Mounted:
    a. Provide cast-in-place concrete base.
    b. Provide branch circuit in-line fuses in pole base handhole.

C. Swinging Type: Provide, at each support, safety cable capable of supporting four times vertical load from structure to luminaire.

D. Finished Areas:

1. Install symmetrically with tile pattern.
2. Locate with centerlines either on centerline of tile or on joint between adjacent tile runs.
3. Install recessed luminaires tight to finished surface such that no spill light will show between ceilings and sealing rings.
4. Combustible Low Density Cellulose Fiberboard: Provide spacers and mount luminaires 1-1/2 inches from ceiling surface, or use fixtures suitable for mounting on low density ceilings.
5. Junction Boxes:
    a. Flush and Recessed Luminaires: Locate minimum 1-foot from luminaire.
    b. In concealed locations, install junction boxes to be accessible by removing luminaire.
6. Wiring and Conduit:
    a. Provide wiring of temperature rating required by luminaire.
    b. Provide flexible steel conduit.
7. Provide plaster frames when required by ceiling construction.
8. Independent Supports:
    a. Provide each recessed fluorescent luminaire with two safety chains or two No. 12 soft-annealed galvanized steel wires of length needed to secure luminaire to building structure independent of ceiling structure.
    b. Tensile strength of chain or wire, and method of fastening to structure shall be adequate to support weight of luminaire.
    c. Fasten chain or wire to each end of luminaire.

E. Unfinished Areas: Locate luminaires to avoid conflict with other building systems or blockage of luminaire light output.

1. Fixture Suspension: Provide 1/4-inch threaded steel hanger rods. Scissor type hangers not permitted.
2. Attachment to Steel Beams: Provide flanged beam clips and straight or angled hangers.

F. Building Exterior: Flush-mounted back box and concealed conduit, unless otherwise indicated.

3.02 LAMPS

A. Provide in each fixture, number and type for which fixture is designed, unless otherwise noted.

3.03 BALLASTS

A. Install in accordance with manufacturer’s recommendations.

B. Utilize all ballast mounting holes to fasten securely within luminaire.

C. Replace noisy or defective ballasts.

3.04 EMERGENCY LIGHTING UNIT

A. Install in accordance with manufacturer’s recommendations.

B. Provide permanent circuit connections with conduit and wire.

C. Connect to branch circuit feeding normal lighting in area ahead of all local switches.

D. Provide separate circuit wiring to luminaire.

3.05 CLEANING

A. Remove labels and markings, except UL listing mark.

B. Wipe luminaires inside and out to remove construction dust.

C. Clean luminaire plastic lenses with antistatic cleaners only.

D. Touch up painted surfaces of luminaires and poles with matching paint ordered from manufacturer.

E. Replace defective lamps at time of Substantial Completion.

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/ft^3 (600 kN-m/m^3)).
   b. D1557, Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft^3 (2,700 kN-m/m^3)).

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. 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.

E. 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 Site clearing and demolition Work as shown 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: Minimum three overlapping passes with three-wheeled power roller weighing approximately 10 tons.

B. Under Pavement Structure, Floor Slabs On Grade, or Granular Fill Under Structures: Compact the upper 8 inches to minimum of 98 percent relative compaction as determined in accordance with ASTM D698.

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 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.

1.04 SEQUENCING AND SCHEDULING

A. Prior to excavation:

1. Prepare site only after adequate erosion and sediment controls are in place.
2. Clear and grub areas actually needed for site improvements within limits shown or specified.
3. Do not injure or deface vegetation that is not designated for removal.
4. Remove rubbish, trash, and junk from entire area within Project Limits.

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. Conduct excavation in accordance with OSHAs Trenching and Excavation regulations.

E. 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.

F. 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.

3.02 UNCLASSIFIED EXCAVATION

A. Excavation is unclassified. Complete all excavation regardless of the type, nature, or condition of the materials encountered.

3.03 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.

3.04 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.

3.05 STOCKPILING EXCAVATED MATERIAL

A. Stockpile excavated material that is suitable for use as fill or backfill until material is needed.

B. Confine stockpiles to within easements, rights-of-way, and approved work areas. Do not obstruct roads or streets.

C. 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.

D. Do not stockpile excavated materials near or over existing facilities, adjacent property, or completed Work, if weight of stockpiled material could induce excessive settlement.

3.06 DISPOSAL OF SPOIL

A. Dispose of excavated materials, which are unsuitable or exceed quantity needed for fill or backfill, offsite.

B. Dispose of debris resulting from removal of organic matter, trash, refuse, and junk.

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/ft^3 (600 kN-m/m^3)).
   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/ft^3 (2,700 kN-m/m^3)).
   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 D698.
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. 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.

D. Completed Course: A course or layer that is ready for next layer or next phase of Work.

E. Lift: Loose (uncompacted) layer of material.

F. Geosynthetics: Geotextiles, geogrids, or geomembranes.

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.

N. Standard Specifications: When referenced in this section, shall mean the current edition of the Georgia Department of Transportation Standard Specifications for Construction of Transportation System. Where reference is made to a specific part of the Standard Specification, such applicable part shall be considered part of this section of the Specification. In case of a conflict in the requirements of the Standard Specifications and the requirements stated herein, the most stringent ones shall prevail.

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 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 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. 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 STRUCTURAL FILL

A. Imported or excavated material free from deleterious matter, clay balls, debris and organic material and having the following properties:

1. Maximum Plasticity Index: 15.
2. Maximum Liquid Limit: 40.
3. Maximum Fine Content (Percent passing No. 200 sieve): 40.
4. Maximum gravel content: 5 percent.
5. USCS Classification: Poorly graded sands (SP) or silty sands (SM).

2.04 WATER FOR MOISTURE CONDITIONING

A. Free of hazardous or toxic contaminates, or contaminants deleterious to proper compaction.

2.05 GRADED AGGREGATE BASE COURSE ROCK

A. As specified in Section 32 11 23, Aggregate Base Courses.

2.06 FOUNDATION STABILIZATION ROCK

A. No. 67 coarse aggregate meeting the requirements of Section 800 of the Standard Specifications.

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 FILL AND 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 structural fill, unless otherwise shown. Place structural fill in lifts of 6-inch maximum thickness and compact each lift to minimum of 98 percent relative compaction as determined in accordance with ASTM D698.

B. Other Areas: Backfill with earthfill to lines and grades shown, with proper allowance for topsoil thickness where shown. Place in lifts of 8-inch maximum thickness and compact each lift to minimum 92 percent relative compaction as determined in accordance with ASTM D698.

C. 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 a minimum 92 percent of the soil's maximum dry density as determined in accordance with ASTM D698.
5. Dress completed embankment with allowance for topsoil, crest surfacing, and slope protection, where applicable.

3.03 SITE TESTING

A. Gradation:

1. One sample from each 500 tons of finished product or more often as determined by Engineer, if variation in gradation is occurring, or if material appears to depart from Specifications.
2. If test results indicate material does not meet Specification requirements, terminate material placement until corrective measures are taken.
3. Remove material placed in Work that does not meet Specification requirements.

B. In-Place Density Tests: In accordance with ASTM D6938. During placement of materials, test as follows:

1. Structural Fill: One test per 12 inches of lift minimum, per 2,000 square feet of area.
2. Graded Aggregate Base Course Rock: One test per lift minimum, per 2,000 square feet of area.

3.04 GRANULAR BASE, SUBBASE, AND SURFACING

A. Place and compact as specified in Section 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: Structural Fill covered with an 8-inch layer of Foundation Stabilization Rock.
2. Beneath Fill or Backfill: Same material as specified for overlying fill or backfill.

3. Beneath Slabs-On-Grade: Structural Fill covered with an 8-inch layer of Foundation Stabilization Rock
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.
5. Permanent Cut Slopes (Where Overlying Area is Not to Receive Fill or Backfill):
   a. Flat to Moderate Steep Slopes (3:1, Horizontal Run: Vertical Rise or Flatter): Earthfill.
   b. Steep Slopes (Steeper than 3:1):
      1) Correct overexcavation by transitioning between overcut areas and designed slope adjoining areas, provided such cutting does not extend offsite or outside easements and right-of-ways, or adversely impacts existing facilities, adjacent property, or completed Work.
      2) Backfilling overexcavated areas is prohibited, unless in Engineer's opinion, backfill will remain stable, and overexcavated material is replaced as compacted earthfill.

END OF SECTION

SECTION 31 23 23.15
TRENCH BACKFILL

PART 1 GENERAL

1.01 DEFINITIONS

A. Bedding Material: Granular material upon which pipes, conduits, cables, or duct banks are placed.

B. Imported Material: Material obtained by Contractor from source(s) offsite.

C. Lift: Loose (uncompacted) layer of material.

D. 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.

E. Prepared Trench Bottom: Graded trench bottom after excavation and installation of stabilization material, if required, but before installation of bedding material.

F. Relative Compaction: The ratio, in percent, of the as-compacted field dry density to the laboratory maximum dry density as determined by ASTM D698. Corrections for oversize material may be applied to either as-compacted field dry density or maximum dry density, as determined by Engineer.

G. Selected Backfill Material: Material available onsite that Engineer determines to be suitable for a specific use.

H. 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. Well-graded does not define any numerical value that must be placed on the coefficient of uniformity, coefficient of curvature, or other specific grain size distribution parameters.

1.02 SUBMITTALS

A. Informational Submittals:

1. 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.

PART 2 PRODUCTS

2.01 TRENCH STABILIZATION MATERIAL

A. Foundation Stabilization Rock as specified in Section 31 23 23, Fill and Backfill.

2.02 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 20 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. 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.
3. Pipe Greater than 18-Inch Diameter: 1-1/2-inch maximum particle size for ductile iron pipe, concrete pipe, welded steel pipe, and pretensioned or prestressed concrete cylinder pipe.
4. 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.

2.03 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.

2.04 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.

2.05 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.

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 the full width of the prepared trench bottom in two equal lifts when the required depth exceeds 8 inches.

C. Hand grade and compact each lift to provide a firm, unyielding surface.

D. Minimum Thickness: 4 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, Direct Buried Cables, and Duct Banks: 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 that voids are completely filled before placing each succeeding lift.

E. After the full depth of the pipe zone material has been placed as specified, compact the material by a minimum of three passes with a vibratory plate compactor only over the area between the sides of the pipe and the trench walls.

F. Do not use power-driven impact compactors to compact pipe zone material.

3.06 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 the 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 the 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.
7. Place in lifts not exceeding thickness of 8 inches.
8. Mechanically compact each lift to a minimum of 95 percent relative compaction prior to placing succeeding lifts.

3.07 REPLACEMENT OF TOPSOIL

A. Replace topsoil in top 6 inches of backfilled trench.

B. Maintain the finished grade of topsoil even with adjacent area and grade as necessary to restore drainage.

3.08 MAINTENANCE OF TRENCH BACKFILL

A. After each section of trench is backfilled, maintain the surface of the backfilled trench even with the adjacent ground surface until final surface restoration is completed.

B. Gravel Surfacing Rock: Add gravel surfacing rock where applicable and as necessary to keep the surface of the backfilled trench even with the adjacent ground surface, and grade and compact as necessary to keep the 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 the surface of the backfilled trench level with the adjacent ground surface.

D. Other Areas: Add excavated material where applicable and keep the surface of the backfilled trench level with the adjacent ground surface.

3.09 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 32 11 23
AGGREGATE BASE COURSES

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):
   a. T11, Standard Method of Test for Materials Finer Than 75μm (No. 200) Sieve in Mineral Aggregates by Washing.
   b. T27, Standard Method of Test for Sieve Analysis of Fine and Coarse Aggregates.
   c. T89, Standard Specification for Determining the Liquid Limit of Soils.
   d. T90, Standard Specification for Determining the Plastic Limit and Plasticity Index of Soils.
   e. T96, Standard Specification for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.
   f. T99, Standard Specification for the Moisture-Density Relations of Soils Using a 2.5 kg (5.5 pound) Rammer and a 305 mm (12 in) Drop.
   g. T180, Standard Specification for Moisture-Density Relations of Soils Using a 4.54 kg (10-lb) Rammer and a 457 mm (18-in) Drop.
   h. T190, Standard Specification for Resistance R-Value and Expansion Pressure of Compacted Soils.
   i. T265, Standard Method of Test for Laboratory Determination of Moisture Content of Soils.
   j. T310, Standard Specification for In-Place Density and Moisture Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).
2. ASTM International (ASTM):
   a. C88, Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate.
   b. D1883, Test Method for CBR (California Bearing Ratio) of Laboratory Compacted Soils.
   c. D2419, Test Method for Sand Equivalent Value of Soils and Fine Aggregate.
   d. D4791, Test Method for Flat Particles, Elongated Particles, or Flat and Elongated Particles in Coarse Aggregate.

1.02 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.

C. Standard Specifications: When referenced in this section, shall mean the current edition of the Georgia Department of Transportation Standard Specifications for Construction of Transportation System. Where reference is made to a specific part of the Standard Specification, such applicable part shall be considered part of this section of the Specification. In case of a conflict in the requirements of the Standard Specifications and the requirements stated herein, the most stringent ones shall prevail.

1.03 SUBMITTALS

A. Informational Submittals:

1. Certified Test Results on Source Materials: Submit copies from commercial testing laboratory 20 days prior to delivery of materials to Project showing materials meeting the physical qualities specified.

PART 2 PRODUCTS

2.01 GRADED AGGREGATE BASE COURSE

A. As specified for Group I Aggregates in Section 815 of the Standard Specifications.

2.02 GRAVEL SURFACING

A. Size No. 57 or No. 67 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. Graded Aggregate Base Course:

1. Maximum Completed Lift Thickness: 6 inches.
2. Completed Course Total Thickness: As shown in the Drawings. Spread lift on preceding course to required cross-section.
3. Lightly blade and roll surface until thoroughly compacted.
4. Add keystone to achieve compaction and as required when aggregate does not compact readily due to 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.
5. Blade or broom surface to maintain true line, grade, and cross-section.

B. Gravel Surfacing:

1. Maximum Completed Lift Thickness: 4 inches.
2. Completed Course Total Thickness: As shown in the Drawings.
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. Proof roll entire subgrade with minimum of 3 passes. Where proof rolling indicates areas of soft subgrade or areas of non-uniform stability, correct the subgrade to a uniform and satisfactory stability.

B. 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.

C. Roll each layer of material until material does not creep under roller before succeeding layer is applied.

D. Commence rolling at outer edges and continue toward center; do not roll center of road first.

E. Apply water as needed to obtain specified densities.

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 Graded 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:

1. Construct base course so areas shall be ready for testing.
2. Allow reasonable length of time for testing laboratory to perform tests and obtain results during normal working hours.
3. Perform a minimum of one test on completed course per 2,000 square feet in accordance with ASTM D698 at locations acceptable to Engineer.

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 12 16
ASPHALT PAVING

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):
   a. M17, Standard Specification for Mineral Filler for Bituminous Paving Mixtures.
   b. M81, Standard Specification for Cut-Back Asphalt (Rapid Curing Type).
   c. M82, Standard Specification for Cut-Back Asphalt (Medium Curing Type).
   d. M140, Standard Specification for Emulsified Asphalt.
   e. M208, Standard Specification for Cationic Emulsified Asphalt.
   f. T166, Standard Method of Test for Bulk Specific Gravity of Compacted Asphalt Mixtures Using Saturated Surface-Dry Specimens.
   g. T176 Standard Method of Test for Plastic Fines in Graded Aggregates and Soils by Use of the Sand Equivalent Test.
   h. T230, Standard Method of Test for Determining Degree of Pavement Compaction of Bituminous Aggregate Mixtures.
   i. T245, Standard Method of Test for Resistance to Plastic Flow of Bituminous Mixtures Using Marshall Apparatus.
   j. T246, Standard Method of Test for Resistance to Deformation and Cohesion of Bituminous Mixtures by Means of Hveem Apparatus.
   k. T247, Standard Method of Test for Preparation of Test Specimens of Bituminous Mixtures by Means of California Kneading Compactor.
   l. T283, Standard Method of Test for Resistance of Compacted Bituminous Mixture to Moisture Induced Damage.
   m. T304, Standard Method of Test for Uncompacted Void Content of Fine Aggregate (Method A).
2. Asphalt Institute (AI):
   a. Manual Series No. 2 (MS-2), Mix Design Methods for Asphalt Concrete.
   b. Superpave Series No. 2 (SP-2), Superpave Mix Design.
3. ASTM International (ASTM):
   a. D2041, Test Method for Theoretical Maximum Specific Gravity and Density of Bituminous Paving Mixtures.

b. D4318, Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.
c. D4791, Test Method for Flat Particles, Elongated Particles, or Flat and Elongated Particles in Coarse Aggregate.
d. D5821, Test Method for Determining the Percentage of Fractured Particles in Coarse Aggregate.
e. D6938, Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods.
f. E329, Specification for Agencies Engaged in the Testing and/or Inspection of Materials Used in Construction.

1.02 DEFINITIONS

A. Combined Aggregate: All mineral constituents of asphalt concrete mix, including mineral filler and separately sized aggregates.

B. Standard Specifications: When referenced in this section, shall mean the current edition of Department of Transportation Georgia Standard Specifications Construction of Roads and Bridges. Where 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 requirements herein shall prevail.

1.03 DESIGN REQUIREMENTS

A. Shop Drawings: Job-mix formula for pavements.

B. Quality Control Submittals:

1. Manufacturer’s Certificate of Compliance for the following materials:
   a. Aggregate: Gradation.
   b. Asphalt for Binder: Type and grade.
   c. Prime Coat: Type and grade of asphalt.
   d. Tack Coat: Type and grade of asphalt.
   e. Mix: Conforms to job-mix formula.
2. Statement of qualification for independent testing laboratory.
3. Manufacturer’s Certificate of Proper Installation.
4. Test Results:
   a. Mix design.
      1) Aggregate gradation.
      2) Asphalt content.
      3) Stability number.
   b. Asphalt concrete core.
      1) Permeability.
      2) Density.

c. Gradation and asphalt content of uncompacted mix.
d. Asphalt cement for binder.

1.04 QUALITY ASSURANCE

A. Qualifications:

1. Independent Testing Laboratory: In accordance with ASTM E329.
2. Asphalt concrete mix formula shall be prepared by approved independent laboratory under the supervision of a certified asphalt technician.

1.05 ENVIRONMENTAL REQUIREMENTS

A. Temperature: Do not apply asphalt materials or place asphalt mixes when ground temperature is lower than 10 degrees C (50 degrees F) or air temperature is lower than 4 degrees C (40 degrees F). Measure ground and air temperature in shaded areas away from heat sources or wet surfaces.

B. Moisture: Do not apply asphalt materials or place asphalt mixes when application surface is wet.

PART 2 PRODUCTS

2.01 MATERIALS

A. Prime Coat: Cut-back asphalt, Grade MC-70 conforming to AASHTO M82.

B. Tack Coat: Emulsified asphalt, conform to Section 413 of the Standard Specifications.

C. Sand (Blotter Material): Clean, dry, with 100 percent passing 4.75-millimeter (No. 4) sieve, and a maximum of 10 percent passing 75 μm (No. 200) sieve.

2.02 ASPHALT CONCRETE MIX

A. Aggregate:

1. General: As specified in Section 802 of the Standard Specifications for hot plant mix bituminous pavement.

B. Mineral Filler: In accordance with Section 883 of the Standard Specifications.

C. Asphalt Concrete Mixture:

1. Asphalt Concrete:
   a. Surface Course: GDOT 12.5 mm Superpave.
   b. As specified in Sections 400 and 828 of Standard Specifications.

D. Blotter Material: As specified in Section 412 of Standard Specifications.

E. Tack Coat: Asphalt cement, Type AC-20 or AC-30, conforming to Section 820 of Standard Specifications.

F. Prime Coat:

1. Liquid asphalt, Grade MC-70 or RC-250, conforming to Section 821 of Standard Specifications.
2. Emulsified asphalt, Grade EAP-1, conforming to Section 822 of Standard Specifications.

G. Asphalt Cement: As specified in Section 820 of the Standard Specifications**.**

H. Source Quality Control:

1. Tests: Furnish services of independent testing laboratory to conduct tests.
   a. Job-Mix Formula for Pavements:
      1) Define gradation for each of the aggregate constituents used in mixture and establish exact proportion for each constituent to produce a gradation of aggregate within specified limits.
      2) Bulk specific gravity for each aggregate constituent.
      3) Measured maximum specific gravity of mix at optimum asphalt content determined in accordance with ASTM D2041.
      4) Properties as stated in Standard Specifications, Section 400, for at least four different asphalt contents other than optimum, two below optimum, and two above optimum.
      5) Percent of asphalt lost due to absorption by aggregate.

I. After each job-mix formula is established, the combined aggregate grading of respective mixture furnished to the Project shall meet tolerances specified in Section 400 of Standard Specifications.

PART 3 EXECUTION

3.01 GENERAL

A. Traffic Control: Minimize inconvenience to traffic, but keep vehicles off freshly treated or paved surfaces to avoid pickup and tracking of asphalt.

B. Driveways: Repave driveways from which pavement was removed. Leave driveways in as good or better condition than before start of construction.

3.02 LINE AND GRADE

A. Provide and maintain intermediate control of line and grade, independent of underlying base, to meet finish surface grades and minimum thickness.

B. Shoulders: Construct to line, grade, and cross-section shown.

3.03 APPLICATION EQUIPMENT

A. In accordance with Section 400 of the Standard Specifications.

3.04 PREPARATION

A. Prepare subgrade as specified in Section 31 23 13, Subgrade Preparation.

B. Existing Roadway:

1. Modify profile by grinding, milling, or overlay methods as approved, to provide meet lines and surfaces and to produce smooth riding connection to existing facility.
2. Remove existing material to a minimum depth of 2 inches.
3. Paint edges of meet line with tack coat prior to placing new pavement.

C. Thoroughly coat edges of contact surfaces (curbs, manhole frames) with emulsified asphalt or asphalt cement prior to laying new pavement. Prevent staining of adjacent surfaces.

3.05 PAVEMENT APPLICATION

A. General: Place asphalt concrete mixture on approved, prepared base in conformance with Section 32 11 23 Aggregate Base Coarse.

B. Prime Coat:

1. Apply uniformly to clean, dry surfaces avoiding overlapping of applications. Touchup missed or lightly coated surfaces.
2. Do not apply when moisture content of upper 75 millimeters (3 inches) of base exceeds optimum moisture content of base, or if free moisture is present.
3. Application Rate: 0.15 to 0.30 gallons per square yard.
4. Remove or redistribute excess material.
5. Allow a minimum of 5 full days for curing of primed surface before placing asphalt concrete.

C. Tack Coat:

1. Tack coat shall be applied where required in accordance with Section 413 of the Standard Specifications.

2. Apply uniformly to clean, dry surfaces avoiding overlapping of applications.
3. Do not apply more tack coat than necessary for the day's paving operation.
4. Touch up missed or lightly coated surfaces and remove excess material.
5. Application Rate:
    a. 0.05 to 0.15 gallon per square yard of surface area.
    b. Engineer will determine application rate, within range specified, at time of application.

D. Pavement Mix:

1. Prior to Paving:
    a. Sweep primed surface free of dirt, dust, or other foreign matter.
    b. Patch holes in primed surface with asphalt concrete pavement mix.
    c. Blot excess prime material with sand.
2. Place asphalt concrete pavement mix in one single lift to a total compacted thickness of 2-1/2 inches.
3. Apply such that meet lines are straight and edges are vertical.
4. Collect and dispose of segregated aggregate from raking process. Do not scatter material over finished surface.

E. Compaction:

1. Roll until roller marks are eliminated and minimum density of 95 percent of mix design unit weight at optimum asphalt content is obtained.
2. Joint Compaction:
    a. Place top or wearing layer as continuously as possible.
    b. Pass roller over unprotected end of freshly laid mixture only when placing of mix is discontinued long enough to permit mixture to become chilled.
    c. Cut back previously compacted mixture when Work is resumed to produce slightly beveled edge for full thickness of layer.
    d. Cut away waste material and lay new mix against fresh cut.

F. Tolerances:

1. General: Conduct measurements for conformity with crown and grade immediately after initial compression. Correct variations immediately by removal or addition of materials and by continuous rolling.
2. Completed Surface or Wearing Layer Smoothness:
    a. Uniform texture, smooth, and uniform to crown and grade.

b. Maximum Deviation: (1/8 inch) from lower edge of a 3.6-meter (12-foot) straightedge, measured continuously parallel and at right angle to centerline.
c. If surface of completed pavement deviates by more than twice specified tolerances, remove and replace wearing surface.

3. Transverse Slope Maximum Deviation: (1/4 inch) in 3.6 meters (12 feet) from rate of slope shown.
4. Finished Grade:
   a. Perform field differential level survey on maximum (50-foot) meter grid and along grade breaks.
   b. Maximum Deviation: 0.02 foot.

G. Seal Coat:

1. General: Apply seal coat of paving grade or emulsified asphalt to finished surface at longitudinal and transverse joints, joints at abutting pavements, areas where asphalt concrete was placed by hand, patched surfaces, and other areas as directed by Engineer.
2. Preparation:
   a. Surfaces that are to be sealed shall be maintained free of holes, dry, and clean of dust and loose material.
   b. Seal in dry weather and when temperature is above 2 degrees C (35 degrees F).
3. Application:
   a. Fill cracks over 1.5 millimeters (1/16 inch) in width with asphalt-sand slurry or approved crack sealer prior to sealing.
   b. When sealing patched surfaces and joints with existing pavements, extend minimum 150 millimeters (6 inches) beyond edges of patches.

3.06 PATCHING

A. Preparation:

1. Remove damaged, broken, or unsound asphalt concrete adjacent to patches. Trim to straight lines exposing smooth, sound, vertical edges.
2. Prepare patch subgrade as specified in Section 31 23 13, Subgrade Preparation

B. Application:

1. Patch Thickness: 4inches or thickness of adjacent asphalt concrete, whichever is greater.
2. Place asphalt concrete mix across full width of patch in layers of equal thickness.
3. Spread and grade asphalt concrete with hand tools or mechanical spreader, depending on size of area to be patched.

C. Compaction:

1. Roll patches with power rollers capable of providing compression of 200 to 300 pounds per linear inch. Use hand tampers where rolling is impractical.
2. Begin rolling top course at edges of patches, lapping adjacent asphalt surface at least 1/2 the roller width. Progress toward center of patch overlapping each preceding track by at least 1/2 width of roller.
3. Make sufficient passes over entire area to remove roller marks and to produce desired finished surface.

D. Tolerances:

1. Finished surface shall be flush with and match grade, slope, and crown of adjacent surface.
2. Tolerance: Surface smoothness shall not deviate more than plus 1/4-inch when straightedge is laid across patched area between edges of new pavement and surface of old surfacing.

3.07 CONNECTIONS WITH EXISTING FACILITIES

A. Where asphalt concrete pavement connects to an existing roadway surface, modify existing roadway profile to produce a smooth riding connection to existing facility.

B. Paint edges of contact surfaces (curbs, concrete pavement, etc), before laying pavement, with tack coat or paving asphalt cement to provide watertight joints. Do not stain adjacent surfaces not intended to be coated.

3.08 FIELD QUALITY CONTROL

A. General: Provide services of approved certified independent testing laboratory to conduct tests.

B. Field Density Tests:

1. Perform tests from cores or sawed samples in accordance with AASHTO T230 and AASHTO T166.
2. Measure with properly operating and calibrated nuclear density gauge in accordance with ASTM D6938.
3. Maximum Density: In accordance with ASTM D2041, using sample of mix taken prior to compaction from same location as density test sample.

C. Testing Frequency:

1. Quality Control Tests: Asphalt Content, Aggregate Gradation: One test.
2. Density Tests: Total of three tests.

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 chlorine concentration testing and 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 and Owner.

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 initial 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:
    a. Pumps and associated system piping.
    b. Treatment plant basins and processes used to supply water to system.

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. Liquid chlorine gas conforming to AWWA B301 and water mixture.
2. Dry chlorine gas conforming to AWWA B301.
3. Calcium hypochlorite conforming to AWWA B300 or sodium hypochlorite conforming to AWWA B303 powder or liquid and water mixture.

B. Feed dry chlorine gas through devices to regulate the rate of flow and ensure uniform diffusion of gas into water within the pipe being treated. Chlorinating devises for feed chlorine gas solution or the gas itself shall prevent backflow of water into chlorine cylinder.

C. Use the following proportions of hypochlorite or chlorine to water:

1. Chlorine Gas or Liquid (100 percent Cl): 1 pound per 11.75 gallons water.
   a. Apply liquid chorine gas-water solution by means of a solution feed chlorinating device.
2. Calcium Hypochlorite (65 to 70 percent Cl): 1 pound per 7.5 gallons water.
   a. 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).
3. Sodium Hypochlorite (5.25 percent Cl): 1 gallon per 4.25 gallons water.
   a. 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, C652 for tanks and reservoirs, and C653 for water treatment plants and filters**,** except as modified in these Specifications.

B. Contractor's Equipment:

1. Furnish chemicals and equipment, such as pumps and hoses, to accomplish disinfection.
2. Water used to fill pipeline may be supplied using a temporary connection to existing distribution system. Provide protection against cross-connections as required by AWWA C651.

C. Disinfect the following items installed or modified under this Project, intended to hold, transport, or otherwise contact potable water:

1. Pumps.
2. Tanks.
3. Filters.
4. Pipelines: Disinfect new pipelines that connect to existing pipelines up to point of connection.
5. 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, tank, filters, 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 AND PIPELINES

A. Cleaning:

1. Before disinfecting, clean foreign matter from pipe in accordance with AWWA C651.

2. If continuous feed method or slug method of disinfection, as described in AWWA C651, are used flush pipelines with potable water until clear of suspended solids and color. Provide hoses, temporary pipes, ditches, and other conduits as needed to dispose of flushing water without damage to adjacent properties.
3. Flush service connections and hydrants. Flush distribution lines prior to flushing hydrants and service connections. Operate valves during flushing process at least twice during each flush.
4. 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. Disinfecting Solutions: Minimum free chlorine concentration of 100 ppm.

B. 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 TANKS AND RESERVOIRS

A. Cleaning:

1. Clean interior surfaces using water under pressure before sterilizing.
2. Isolate tank and reservoir from system to prevent contaminating materials from entering distribution system.
3. Cleaning shall:
   a. Remove deposits of foreign nature.
   b. Remove biological growths.
   c. Clean slopes, walls, top, and bottom.
   d. Avoid damage to structure.
   e. Avoid pollution or oil deposits by workers and equipment.

4. Dispose of water used in cleaning in accordance with applicable regulations before adding disinfecting solution to tank and reservoir.

B. Disinfecting Procedure: In accordance with AWWA C652, unless herein modified. Parts of structures, such as ceilings or overflows that cannot be immersed, shall be spray or brush disinfected.

3.06 FILTERS

A. Prior to disinfection, remove foreign material from filtration structures. Clean using fire hoses and tools suitable for adequate scrubbing and cleaning. Pump or drain scrub water from structures.

B. Disinfection Procedure: In accordance with AWWA C653, unless herein modified.

C. Clean other new facilities designed to hold or transport process water prior to disinfection of filter system.

3.07 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.

3.08 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 laboratory.

C. Chlorine Concentration Sampling and Analysis: Collect and analyze Samples in accordance with AWWA C653.

D. After tanks, reservoirs, filters, pumps, and pipelines have been cleaned, disinfected, and refilled with potable water, Contractor 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. Obtain and analyze a minimum of two Samples on each of 2 consecutive days from each separable structure and every 1,000 feet of pipeline by standard procedures outlined by state and local regulatory agencies.
4. 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.
2. Identify support, hanger, guide, and anchor type by catalog number and Shop Drawing detail number.

3. Calculations for each type of pipe support, attachment and anchor.
4. Revisions to support systems resulting from changes in related piping system layout or addition of flexible joints.
5. 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 and Shop Drawings prepared and sealed by a Registered Professional Engineer in the state where the Work is to be installed.

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. 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 to120-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 though 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: 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. Aickinstrut (FRP System).
2. Enduro-Durostrut (FRP Systems).

2.06 PIPE CLAMPS

A. Flush Mount Pipe Strap: MSS SP 58, Type 26.

1. Anvil; Figure 262, sizes 1/2 inch through 4 inches.
2. B-Line; Figure B3180FL.

B. 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.

2.07 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.

2.08 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.

2.09 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.

2.10 PIPE ANCHORS

A. Type: Anchor chair with U-bolt strap.

B. Manufacturer and Product: B-Line; Figure B3147A or Figure B3147B.

2.11 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.

2.12 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. Welded Beam Attachment: MSS SP 58, Type 22.
   a. Anvil; Figure 66.
   b. B-Line; Figure B3083.
3. 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. Concrete Walls: Brackets or clip angles with concrete anchors.

D. 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.

E. 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 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**
Pipe Galleries and Vaults	Galvanized steel or precoated steel, plastic coated hangers for uninsulated copper piping
Process Areas: High Humidity	Stainless steel or FRP
Process Areas: Wetted or Submerged	Stainless steel or FRP

Notes:

1. Precoated steel to be fusion bonded epoxy or vinyl copolymer (Plastisol).
2. Stainless steel to be Type 304.
3. Galvanized steel to be per ASTM A653/A653M, Class G90, or hot-dip galvanized after fabrication to ASTM A123/A123M.
4. Do not use galvanized steel or aluminum where lime dust can accumulate on these surfaces.

Table 2 Chemical Areas		
Exposure Conditions	**Support for Direct Exposure**	**Support for Remote Exposure**
Sulfuric Acid	Stainless steel	Precoated steel

Notes:

1. Direct exposure includes entire area within containment area; area within 20 feet horizontal and 10 feet vertical of chemical pumps or chemical mixing stations; or as specified.
2. Remote exposure is area beyond area defined as direct exposure, but within designated building.
3. Precoated steel to be fusion bonded epoxy or vinyl copolymer (Plastisol).
4. Stainless steel to be Type 304.
5. Galvanized steel to be per ASTM A653/A653M, Class G90, or hot-dip galvanized after fabrication to ASTM A123/A123M.
6. Do not use galvanized steel or aluminum where lime dust can accumulate on these surfaces.

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, Process Piping—General, and shall include a 10 percent safety factor.
2. 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: As indicated by branch circuits provided for heat tracing on the Drawings.

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, STRAPS, AND ADAPTERS

A. Securing Strap: Type stainless steel Raychem PS or equal.

B. Adapters: As recommended by manufacturer.

C. 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.

D. 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. Provide labeling indicating that insulated piping is heat traced.
4. Ground metallic structures or materials used for support of heating cable or on which it is installed in accordance with applicable codes.
5. Wiring between power connection points of heat tracing cable branch lines shall be provided by heat tracing system supplier.
6. Provide end of circuit pilot lights on heat tracing circuits for buried piping.
7. For cases where heat trace circuits are shown to penetrate containment walls, heat trace cable shall be routed in corrosion and UV-resistant flexible conduit up and over containment wall in a manner that basically extends the heat trace circuit to the piping on both sides of the containment wall without penetrating the containment wall. The corrosion and UV-resistant flexible conduit provides physical protection of the heat trace cable.

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. Derate heating tape capacity when installed on plastic piping.

4. Install on services as follows:

Service	Piping Material	Placement	Location
ALP	SST	Exterior exposed greater than 6 inch and less than 10 inch	Filter Building
PAC	PVC	Exposed 4 inches and smaller	Powdered Activated Carbon Feed System
PUR	CPVC	Exposed – 4 inches and smaller	Outside of chemical building at bulk chemical storage
SU	PVC	Exposed – 4 inches and smaller	Outside of chemical building at bulk chemical storage
W1	PVC	Exposed – 4 inches and smaller	Outside of chemical building at bulk chemical storage and at Powdered Activated Carbon Feed System

5. 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
PROCESS 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.
3. Sanitary Building Drainage and Vent Systems: ICC International Plumbing Code.
4. Buried Piping: H20-S16 traffic load with 1.5 impact factor, AASHTO HB-17, as applicable.
5. 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. 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.
2. Hydraulic Thrust Restraint for Restrained Joints: Details including materials, sizes, assembly ratings, and pipe attachment methods.
3. Thrust Blocks: Concrete quantity, bearing area on pipe, and fitting joint locations.
4. Dissimilar Buried Pipe Joints: Joint types and assembly drawings.
5. Pipe Corrosion Protection: Product data.
6. 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 torqueing 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: 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 Division 01, General 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. Fabricated Steel Piping (Except Cement-Lined): Outside diameter, ASME B36.10M.
3. Cement-Lined Steel Pipe: Lining inside diameter.

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. Mechanical Joint Anchor Gland Follower:

1. Ductile iron anchor type, wedge action, with break-off tightening bolts.
2. Thrust rated to 250 psi minimum.
3. Rated operating deflection not less than:
   a. 3 degrees for sizes through 12 inches.
   b. 2 degrees for sizes 14 inches through 16 inches.
   c. 1.5 degrees for sizes 18 inches through 24 inches.
   d. 1 degree for sizes 30 inches through 48 inches.
4. UL and FM approved.

E. Flexible Mechanical Compression Joint Coupling:

1. Stainless steel, ASTM A276, Type 305 bands.
2. Manufacturers:
   a. Pipeline Products Corp.
   b. Fernco Joint Sealer Co.

F. Mechanical connections of high-density polyethylene pipe to auxiliary equipment such as valves, pumps, tanks, and other piping systems shall be through-flanged connections consisting of the following:

1. Polyethylene stub end thermally butt-fused to end of pipe.
2. ASTM A240/A240M, Type 304 stainless steel backing flange, 125-pound, ASME B16.1 standard. Use insulating flanges where shown.
3. Bolts and nuts of sufficient length to show a minimum of three complete threads when joint is made and tightened to manufacturer's standard. Retorque nuts after 4 hours.
4. Gaskets as specified on Data Sheet.

2.04 GASKET LUBRICANT

A. Lubricant shall be supplied by pipe manufacturer and no substitute or "or-equal" will be allowed.

2.05 DOUBLE WALL CONTAINMENT PIPING SYSTEM

A. System components shall be pre-engineered, factory fabricated, tested, and assembled such that field assembly is minimized to primarily that of straight joints.

2.06 PIPE CORROSION PROTECTION

A. Coatings: See Section 09 90 00, Painting and Coating, for details of coating requirements.

B. Heat Shrink Wrap:

1. Type: Cross-linked polyolefin wrap or sleeve with mastic sealant.
2. Manufacturer and Product: Raychem; WPC or TPS.

C. Polyethylene Encasement (Bagging):

1. Encasement Tube: Black polyethylene encasement tube, 8 mils minimum thickness, conforming to AWWA C105/A21.5, free of gels, streaks, pinholes, foreign matter, undispersed raw materials, and visible defects such as tears, blisters, and thinning at folds.
2. Securing Tape: Thermoplastic tape, 8 mils minimum thickness, 1-inch wide, pressure sensitive adhesive face capable of bonding to metal, bituminous coating, and polyethylene encasement tube.

D. 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 fiberglass reinforced epoxy (NEMA LI-1, G-10 grade).
   c. Insulating Washers: High-strength phenolic. Fiberglass-reinforced epoxy (NEMA LI-1, G-10 grade).
   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:
   c. Dresser; STAB-39.
   d. Baker Coupling Company, Inc.; Series 216.

2.07 THRUST BLOCKS

A. Concrete: As specified in Section 03 30 00, Cast-in-Place Concrete.

2.08 THRUST TIES

A. Steel Pipe: Joint harness as specified in Section 40 27 01, Process Piping Specialties.

B. Buried Ductile Iron Pipe and Fittings: Unless restraint is otherwise specified or shown, conform to NFPA 24. Tie-rod attachments relying on clamp friction with pipe barrel to restrain thrust are unacceptable.

2.09 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.

2.10 FABRICATION

A. 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.

2.11 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. Clean stainless steel joints with stainless steel wire brushes or stainless steel wool prior to welding.
3. 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:

1. 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.

2. Stainless Steel and Alloy Piping: If ambient is less than 32 degrees F, local preheating to a temperature warm to the hand is required.

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.

I. Ductile Iron Piping:

1. Cutting Pipe: Cut pipe with milling type cutter, rolling pipe cutter, or abrasive blade cutter. Do not flame cut.
2. Dressing Cut Ends:
   a. General: As required for the type of joint to be made.
   b. Rubber Gasketed Joints: Remove sharp edges or projections.
   c. Push-On Joints: Bevel, as recommended by pipe manufacturer.
   d. Flexible Couplings, Flanged Coupling Adapters, and Grooved End Pipe Couplings: As recommended by the coupling or adapter manufacturer.

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: Provide flexible mechanical compression joints for pressure pipe.
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. 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.
10. After joint has been made, check pipe alignment and grade.
11. Place sufficient pipe zone material to secure pipe from movement before next joint is installed.
12. Prevent uplift and floating of pipe prior to backfilling.

C. PVC, CPVC, or HDPE 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 Horizontal Line, Except PVC, CPVC, or HDPE: Maximum 2 inches.
2. Deflection From Vertical Grade: Maximum 1/4 inch.
3. Joint Deflection: Maximum of 75 percent of manufacturer's recommendation.
4. Horizontal position of pipe centerline on alignment around curves maximum variation of 1.75 feet from position shown.
5. Pipe Cover: Minimum 3 feet, unless otherwise shown.

3.07 INSTALLATION—CONCRETE ENCASED

A. Provide reinforced concrete pipe encasement where shown on Drawings and where otherwise required. Some piping may be required to be concrete encased for pipe strength requirements that are included in the Specifications. Piping under and within the influence of buildings, utility trenches, vaults, slabs, and other structures shall be concrete encased. See details on Drawings for encasement requirements.

B. Where concrete encased piping crosses structure construction and expansion joints, provide flexible piping joints to coincide with structure joints to prevent excessive pipe stress and breakage.

3.08 PIPE CORROSION PROTECTION

A. Ductile Iron Pipe:

1. Exposed: As specified in Section 09 90 00, Painting and Coating, and as shown in Piping Schedule.
2. Buried: Wrap with polyethylene bagging.
3. Submerged or Embedded: Coat with coal-tar epoxy as specified in Section 09 90 00, Painting and Coating. If in potable water service, use NSF/ANSI 61 approved epoxy.

B. Carbon Steel Pipe:

1. Exposed: As specified in Section 09 90 00, Painting and Coating.
2. Buried:
   a. Pipe: Wrap with tape coating system as specified in Section 09 90 00, Painting and Coating.
   b. Joints: Wrap with tape coating system as specified in Section 09 90 00, Painting and Coating, or heat shrink wrap as specified herein.
3. Submerged or Embedded: Shop coat with coal-tar epoxy as specified in Section 09 90 00, Painting and Coating. If in potable water service, use NSF/ANSI 61 approved epoxy.

C. Copper Pipe:

1. Exposed: As specified in Section 09 90 00, Painting and Coating.

D. PVC and CPVC Pipe, Exposed: As specified in Section 09 90 00, Painting and Coating.

E. 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 or coat with cement.
   d. Buried Valves and Similar Elements on Wrapped Pipelines: Coat with bituminous paint and wrap entire valve in polyethylene encasement.
   e. Cement-Coated Pipelines: Cement coat appurtenances same as pipe.

F. Polyethylene Encasement: Install in accordance with AWWA C105/A21.5 and manufacturer's instructions.

G. Tape Coating System: As specified in Section 09 90 00, Painting and Coating.

H. Heat Shrink Wrap: Apply in accordance with manufacturer's instructions to surfaces that are cleaned, prepared, and primed.

I. 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. Insulating joints connecting immersed piping to nonimmersed piping shall be installed above maximum water surface elevation.

b. Submerged carbon steel, ductile iron, or galvanized piping in reinforced concrete shall be isolated from the concrete reinforcement steel.
c. 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.

3.09 THRUST RESTRAINT

A. Location:

1. Buried Piping: Where shown and where required to restrain force developed at pipeline tees, plugs, caps, bends, and other locations where unbalanced forces exist because of hydrostatic testing and normal operating pressure.
2. Exposed Piping: At all joints in piping.

B. Thrust Ties:

1. Steel Pipe: Attach with joint harness specified in Section 40 27 01, Process Piping Specialties.
2. Ductile Iron Pipe: Attach with socket clamps anchored against grooved joint coupling or flange.
3. Flanged Coupling Adapters: For exposed installations, install manufacturer's anchor studs through coupling sleeve or use dismantling joints.

C. Mechanical Joint Valve Restraint in Proprietary Restrained Joint Piping: Install pipe joint manufacturer's adapter gland follower and pipe end retainer, or mechanical joint anchor gland follower.

D. Thrust Blocking:

1. Place between undisturbed ground and fitting to be anchored.
2. Quantity of Concrete: Sufficient to cover bearing area on pipe and provide required soil bearing area as shown.
3. Place blocking so that pipe and fitting joints will be accessible for repairs.
4. Place concrete in accordance with Section 03 30 00, Cast-in-Place Concrete.

3.10 SLAB, FLOOR, WALL, AND ROOF PENETRATIONS

A. Application and Installation: As specified in Section 40 27 01, Process Piping Specialties.

3.11 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.

3.12 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 as shown.

3.13 INSULATION

A. See Section 40 42 13, Process Piping Insulation.

3.14 HEAT TRACING

A. See Section 40 05 33, Pipe Heat Tracing.

3.15 DISINFECTION

A. See Section 33 13 00, Disinfecting of Water Utility Distribution.

3.16 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.

3.17 PIPE IDENTIFICATION

A. As specified in Section 10 14 00, Signage and 09 90 00, Painting and Coating.

3.18 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.

3.19 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. Blow clean of loose debris plant process air, and instrument air lines with compressed air at 4,000 fpm; do not flush with water.

C. Insert cone strainers in flushing connections to attached equipment and leave in-place until cleaning is complete.

D. Remove accumulated debris through drains 2 inches and larger or by removing spools and valves from piping.

3.20 SUPPLEMENTS

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

1. Piping Schedule Legend.
2. Piping Schedule.
3. Data Sheets.

Number	Title
40 27 00.01	Cement-Mortar-Lined Ductile Iron Pipe and Fittings
40 27 00.03	Carbon Steel Pipe and Fittings—General Service
40 27 00.08	Stainless Steel Pipe and Fittings—General Service
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 LEGEND

SERVICE

A	Air
AHP	Air-High Pressure
ALP	Air-Low Pressure
RD	Roof Drain
SD	Storm Drain
SS	Sanitary Sewer
V	Vents
W1	Water-Potable
W2	Water-Non Potable

EXPOSURE

ALL	All
BUR	Buried
EXP	Exposed
SUB	Submerged
ENC	Concrete Encased

MATERIAL

BSP	Black Steel Pipe
CLDI	Cement-Lined Ductile Iron
CMP	Corrugated Metal Pipe
COP	Copper
CPVC	Chlorinated PVC
DI	Ductile Iron

FRPX	Fiberglass Reinforced Plastic Pipe Type (X = 1 to 3)
GLDI	Glass-Lined Ductile Iron
GSP	Galvanized Steel Pipe
HDPE	High-Density Polyethylene
PCCP	Prestressed Concrete Cylinder Pipe
PSTL	PVDF-Lined Steel
PVC	Polyvinyl Chloride
PVDF	Polyvinylidene Fluoride
RCP	Reinforced Concrete Pipe
RSTL	Rubber-Lined Steel
SST	Stainless Steel
STL	Steel
VC	Vitrified Clay Pipe
WS	Fabricated Welded Steel

JOINT TYPE

FL	Flanged
GR	Grooved
HU	Hub and spigot
PRJ	Proprietary Restrained
RM	Restrained Mechanical
S	Screwed
W	Welded (including solvent and fusion)

PRESSURE TEST

G	Gravity Service: Test pressure is not shown on gravity services. Test to highest liquid level that pipe can be subject to.
H	Hydrostatic
I	In Service
P	Pneumatic
PC	Test per Uniform Plumbing Code
NA	Not Applicable

Piping Schedule										
Service	**Legend**	**Size(s) (In.)[1]**	**Exposure**	**Piping Material**	**Specification Section**	**Joint Type**	**Lining/ Coating[2]**	**Test Pressure and Type (psig-x), x = Type indicated in Legend**	**Pipe Color and Label**	**Remarks**
Air, Low Pressure	ALP	<1	EXP	SST	40 27 00.08	FL/ S		100, P		
Air, Low Pressure	ALP	1-2	EXP	BSP		S		100, P	Purple, Air Process	
Air, Low Pressure	ALP	8-10	EXP	SST	40 27 00.08	FL		100, P		
Chlorine Dioxide	CLO	ALL	EXP, BUR	PVC	40 27 00.10	W		100, H	Safety Yellow, Chlorine Dioxide	
Drain	DR	2-6	ALL	PVC	40 27 00.10	W		G	Dark Brown, Drain	
Purate	PUR	ALL	EXP, BUR	CPVC	40 27 00.11	W		15, H	Gray, Purate	
Sulfuric Acid	SU	ALL	EXP, BUR	CPVC	40 27 00.11	W		15, H	Safety Yellow with Safety Red Bands, Sulfuric Acid	
Vent	V	ALL	EXP	CPVC	40 27 00.11	W			Same as service, Vent	
Water, Non Potable	W2	ALL	EXP	PVC	40 27 00.10	W		150, H	Light Blue with Yellow Band, Non- Potable Water	

Piping Schedule										
Water, Potable	W1	<=3”	BUR, ENC	PVC	40 27 00.10	W	None	150/H	None	

[1]“>” Greater Than
“<” Less Than
“<=” Less Than or Equal To
“>=” Greater Than or Equal To
“All” All Sizes

[2]Coating system number as specified in Section 09 90 00, Painting and Coating, and as specified in Article Pipe Corrosion Protection.

SECTION 40 27 00.01 CEMENT-MORTAR-LINED DUCTILE IRON PIPE AND FITTINGS	
Item	**Description**
General	Materials in contact with potable water shall conform to NSF 61 acceptance. Pipe manufacturer shall submit certification that source manufacturing facility has been producing ductile iron pipe of the specified diameters, dimensions, and standards for a period of not less than 10 years. Testing of pipe required by AWWA A21.51 shall be conducted in testing and laboratory facilities located in the USA and operating under USA laws and regulations. Pipe shall be handled during manufacture and shipped without nesting (without insertion of one pipe inside another).
Pipe	Buried Liquid Service Using Proprietary Restrained Joints: AWWA C111/A21.11, and AWWA C151/A21.51, pressure class conforming to Table 5 and Table 7 for Type 4 trench, 250 psi minimum working pressure. Follower glands shall be ductile iron. Exposed Pipe Using Grooved End and Flange Joints: AWWA C115/A21.15, thickness Class 53 minimum, 250 psi minimum working pressure.
Lining	Cement-mortar: AWWA C104/A21.4.
Fittings	Lined and coated same as pipe. Proprietary Restrained: AWWA C110/A21.10, AWWA C111/A21.11, and AWWA C153/A21.53, ductile iron, 250 psi minimum working pressure. Restraint shall be achieved with removable metal elements fitted between a welded bar on the pipe barrel and the inside of the joint bell or fitting sizes smaller than 16 inches may be mechanical joint, restrained by anchor gland followers, ductile iron anchor type, wedge action, with break-off tightening bolts. Assembled joints shall be rated for deflection in operation at rated pressure. Rated deflection shall be not less than 1-1/2 degrees for 36-inch and smaller pipe. Rated deflection shall be not less than 1/2 degree for 42-inch and larger pipe. Clow Corp., American Cast Iron Pipe Co., U.S. Pipe. Restrained joints relying on metal teeth molded into the gasket to prevent joint separation under pressure will not be accepted. Flange: AWWA C110/A21.10 ductile iron, faced and drilled, Class 125 flat face. Gray cast iron will not be allowed.

SECTION 40 27 00.01 CEMENT-MORTAR-LINED DUCTILE IRON PIPE AND FITTINGS	
Item	**Description**
Joints	Proprietary Restrained: 150 psi minimum working pressure. Clow Corp., Super-Lock; American Cast Iron Pipe Co., Flex-Ring or Lok-Ring; U.S. Pipe, TR Flex. Grooved End: Rigid type radius cut conforming to AWWA C606, 250 psi minimum working pressure; Victaulic. Flange: Class 125 flat face, or Class 250 raised face, ductile iron, threaded conforming to AWWA C115/A21.15. Gray cast iron will not be allowed. Branch connections 3 inches and smaller, shall be made with service saddles as specified in Section 40 27 01, Process Piping Specialties.
Couplings	Grooved End: 250 psi minimum working pressure, malleable iron per ASTM A47/A47M or ductile iron per ASTM A536; Victaulic. Grooved End Adapter Flanges: 250 psi minimum working pressure, malleable iron per ASTM A47/A47M or ductile iron per ASTM A536; Victaulic.
Bolting	Mechanical, Proprietary Restrained, and Grooved End Joints: Manufacturer's standard. Class 125 Flat-Faced Flange: ASTM A307, Grade A carbon steel hex head bolts, ASTM A563, Grade A carbon steel hex head nuts and ASTM F436/F436M hardened steel washers at nuts and bolt heads. Achieve 40 percent to 60 percent of bolt minimum yield stress.
Gaskets	General: Gaskets in contact with potable water shall be NSF 61 certified. Proprietary Restrained Joints; Water and Sewage Service: Rubber conforming to AWWA C111/A21.11. Flanged, Water Services: 1/8-inch thick, homogeneous black rubber (EPDM), hardness 60 (Shore A), rated to 275 degrees F, conforming to ASME B16.21 and ASTM D2000 4CA 415 A25 B35 C32 EA14 F19. Full face for Class 125 flat-faced flanges, flat-ring type for Class 250 raised-face flanges. Blind flanges shall be gasketed covering entire inside face with gasket cemented to blind flange. Gasket pressure rating to equal or exceed the system hydrostatic test pressure.
Joint Lubricant	Manufacturer's standard.

END OF SECTION

SECTION 40 27 00.03 CARBON STEEL PIPE AND FITTINGS—GENERAL SERVICE		
Item	**Size**	**Description**
Pipe	All Screwed: 2" & smaller	Black carbon steel, ASTM A106/A106M, Grade B seamless or ASTM A53/A53M, Grade B seamless or ERW. Threaded, butt-welded, grooved end, and flanged joints: Schedule 40.
Joints	2" & smaller	Threaded or flanged at valves and equipment or grooved end meeting the requirements of AWWA C606.
Fittings	2" & smaller	Threaded: 150- or 300-pound malleable iron, ASTM A197/A197M or ASTM A47/A47M, dimensions in accordance with ASME B16.3. Fire sprinkler fittings to be UL listed. Grooved End: Malleable iron ASTM A47/A47M or ductile iron ASTM A536, grooved ends to accept couplings without field preparation. Victaulic Co.; Anvil International, Inc., Gruvlok.
Branch Connections	2" & smaller	For threaded pipe: Threaded, straight, or reducing tees in conformance with Fittings specified above. For welded or grooved pipe, use threadolet.
Flanges	2" & smaller	Forged carbon steel, ASTM A105/A105M, Grade II, ASME B16.5 Class 150 or Class 300 socket-weld or threaded, 1/16-inch raised face.
Unions	2" & smaller	Threaded malleable iron, ASTM A197/A197 or ASTM A47/A47M, 150- or 300-pound WOG, meeting the requirements of ASME B16.3.

SECTION 40 27 00.03 CARBON STEEL PIPE AND FITTINGS—GENERAL SERVICE		
Item	**Size**	**Description**
Bolting	All	Flanges: Carbon steel ASTM A307, Grade A hex head bolts; ASTM A563, Grade A hex head nuts and ASTM F436/F436M hardened steel washers at nuts and bolt heads. Achieve 40 percent to 60 percent of bolt minimum yield stress. When mating flange on equipment is cast iron and gasket is flat ring, provide ASTM A307, Grade B hex head bolts; ASTM A563, Grade A heavy hex nuts and ASTM F436/F436M hardened steel washers at nuts and bolt heads. Achieve 40 percent to 60 percent of bolt minimum yield stress. Grooved End Couplings: Carbon steel, ASTM A183 bolts and nuts, 110,000 psi minimum tensile strength.
Gaskets	All flanges	Water, Steam, and Air Services: 1/16-inch thick, compressed inorganic fiber with nitrile binder, rated 400 degrees F continuous. Fuel Gas Service: 1/8-inch thick, homogeneous black rubber (EPDM), hardness 60 (Shore A), rated 250 degrees F. continuous and conforming to ASME B16.21 and ASTM D1330, Steam Grade. Blind flanges shall be gasketed covering the entire inside face with the gasket cemented to the blind flange. Grooved Couplings: EPDM per ASTM D2000 for water and oil-free air to 230 degrees F, nitrile for oil vapor in air and oil services to 180 degrees F.
Thread Lubricant	2" & smaller	General Service: 100 percent virgin PTFE Teflon tape. Fuel Gas Service: Yellow Teflon tape designed for fuel gas service, Air Force A-A-58092, AA Thread Seal Tape, Inc.

END OF SECTION

SECTION 40 27 00.08 STAINLESS STEEL PIPE AND FITTINGS—GENERAL SERVICE		
Item	**Size**	**Description**
Pipe	2-1/2" & smaller	Schedule 40S: ASTM A312/A312M, Type 304 seamless, pickled and passivated.
	3" thru 6"	Schedule 10S: ASTM A778, "as-welded" grade, Type 304L, pickled and passivated.
	8" & larger	Schedule 5S: ASTM A778, "as-welded" grade, Type 304L, pickled and passivated.
Tubing	All	ASTM A269, Type 316 stainless steel, seamless, fully annealed hydraulic tubing, 0.065-inch wall thickness minimum.
Joints	1-1/2" & smaller	Threaded or flanged at equipment as required or shown.
	2" & larger	Butt-welded or flanged at valves and equipment.
Tubing Joints	All	Flareless compression fitting
Fittings	1-1/2" & smaller	Threaded: Forged 1,000 CWP minimum, ASTM A182/A182M, Grade F304 or cast Class 150, ASTM A351/A351M, Grade CF8/304.
	2" & 2-1/2"	Butt Welded: ASTM A403/A403M, Grade WP304L conforming to ASME B16.9 and MSS SP 43, annealed, pickled and passivated; fitting wall thickness to match adjoining pipe; long radius elbows, unless shown otherwise.
	3" & larger	Butt-Welded: ASTM A774/A774M Grade 304L conforming to MSS SP 43, "as-welded" grade, pickled and passivated; fitting wall thickness to match adjoining pipe; long radius elbows, unless shown otherwise.
Tubing Fittings	All	Flareless Compression Type Forged: ASTM A182/A182M, Grade F316, Parker-Hannifin Ferulok, Flodar BA Series.

SECTION 40 27 00.08 STAINLESS STEEL PIPE AND FITTINGS—GENERAL SERVICE		
Item	**Size**	**Description**
Branch Connections	1-1/2" & smaller	Tee or reducing tee in conformance with fittings above.
	2" & larger	Butt-welding tee or reducing tee in accordance with fittings above.
Tubing Branch Connections	All	Compression type tees or reducing tees in accordance with Tubing Fittings above.
Flanges	All	Forged Stainless Steel: ASTM A182/A182M, Grade F304L, ASME B16.5 Class 150 or Class 300, slip-on weld neck or raised face. Weld slip-on flanges inside and outside. Cast Carbon Steel: ASTM A216/A216M Grade WCA, drilled, ASME B16.5 Class 150 or Class 300 Van Stone Type with stainless steel stub ends, ASTM A240 Type 304L "as-welded grade", conforming to MSS SP 43, wall thickness same as pipe. Blind Flanges, exposed to the atmosphere and not buried nor immersed in liquid, may be either stainless steel or Class 125 ductile iron or Class 150 carbon steel with gaskets as specified herein.
Unions	2" & smaller	Threaded Forged: ASTM A182/A182M, Grade F304, 2,000-pound or 3,000-pound WOG, integral ground seats, AAR design meeting the requirements of ASME B16.11, bore to match pipe.

SECTION 40 27 00.08 STAINLESS STEEL PIPE AND FITTINGS—GENERAL SERVICE		
Item	**Size**	**Description**
Bolting	All	Forged Flanges: Type 304 stainless steel, ASTM A320/A320M Grade B8M hex head bolts, ASTM A194/A194M Grade 8M hex head nuts and ASTM F436/F436M Type 3 alloy washers at nuts and bolt heads. Achieve 40 percent to 60 percent of bolt minimum yield stress. Van Stone Flanges and anywhere mating flange on equipment is cast iron and gasket is flat ring: Carbon steel ASTM A307 Grade B hex head bolts, ASTM A563 Grade A hex head nuts and ASTM F436/F436M hardened steel washers at nuts and bolt heads. Achieve 40 percent to 60 percent of bolt minimum yield stress. Flanged Joints in Sumps, Wet Wells, and Submerged and Wetted Installations: Type 316 stainless steel, ASTM A320/A320M, Grade B8M hex head bolts and ASTM A194/A194M, Grade 8M hex nuts and ASTM F436/F436M Type 3 alloy washers at nuts and bolt heads. Achieve 40 percent to 60 percent of bolt minimum yield stress.
Gaskets	All Flanges	Flanged, Water, Hot Air, Fuel Gas and Sewage Services: 1/8-inch thick, homogeneous black rubber (EPDM), hardness 60 (Shore A), rated to 250 degrees F continuous and conforming to ASME B16.21 and ASTM D1330, Steam Grade. Blind flanges shall be gasketed covering entire inside face with gasket cemented to blind flange.
Thread Lubricant	2" & smaller	General Service: 100 percent virgin PTFE Teflon tape.

END OF SECTION

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.

SECTION 40 27 00.10 POLYVINYL CHLORIDE (PVC) PIPE AND FITTINGS		
Item	**Size**	**Description**
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.
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. 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 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. Chemical Injectors:
   a. Type, size, quantity, materials, and model number of each.
   b. Sketch of each showing major parts, main pipe, and dimensions.

c. Details and model number of each support system and component.
d. Details and model of connects (for example, service saddle, weld-o-let).

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.
2. Operation and Maintenance Data as specified in Section 01 78 23, Operation and Maintenance Data.

1.03 EXTRA MATERIALS

A. Furnish, tag, and box for shipment and storage the following spare parts and special tools for basket strainer:

Item	**Quantity**
Basket	One for each strainer
Disc seals	One for each strainer
Special tools required to maintain or dismantle	One complete set

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. Elastomer Bellows Connector:

1. Type: Fabricated spool, with single filled arch.
2. Materials: Nitrile tube and wrap-applied neoprene cover.
3. End Connections: Flanged, drilled 125-pound ASME B16.1 standard, with full elastomer face and steel retaining rings.
4. Working Pressure Rating: 140 psig, minimum, at 180 degrees F for sizes 12 inches and smaller.
5. Thrust Restraint: Control rods to limit travel of elongation and compression.
6. Manufacturers and Products:
   a. Goodall Rubber Co.; Specification E-1462.
   b. Garlock; Style 204.
   c. Unisource Manufacturing, Inc.; Style 1501.
   d. Proco Products, Inc.; Series 220.

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 COUPLINGS

A. General:

1. Coupling linings for use in potable water systems shall be in conformance with NSF/ANSI 61.
2. Couplings shall be rated for working pressure not less than indicated in Piping Schedule for the service and not less than 150 psi.
3. Couplings shall be lined and coated with fusion-bonded epoxy in accordance with AWWA C213.

4. Unless thrust restraint is provided by other means, couplings shall be harnessed in accordance with requirements of AWWA Manual M11 or as shown on Drawings.
5. Sleeve type couplings shall conform to AWWA C219 and shall be hydraulically expanded beyond minimum yield for accurate sizing and proofing of tensile strength.

B. Bolted Split Sleeve Type Expansion Coupling:

1. Used for ALP pipes as indicated on Drawings.
2. Seal and provide for axial movement (expansion and contraction) at pipe joint.
3. Furnished with restraint rings that ensure expansion coupling is in the proper position over pipe ends when affixed to one of pipe ends.
4. Manufacturers and Products: Victaulic Co., Depend-O-Lok FxE Couplings Type 1.

C. Restrained Flange Adapter:

1. Pressure Rating:
   a. Minimum Working Pressure Rating: Not less than 150 psi.
   b. Safety Factor: Not less than two times working pressure and shall be supported by manufacturer’s proof testing.
2. Thrust Restraint:
   a. Provide hardened steel wedges that bear against and engage outer pipe surface, and allow articulation of pipe joint after assembly while wedges remain in their original setting position on pipe surface.
   b. Products employing set screws that bear directly on pipe will not be acceptable.
3. Manufacturer and Product: EBAA Iron Sales Co.; Mega-Flange.

2.04 SERVICE SADDLES

A. Double-Strap Iron:

1. Pressure Rating: Capable of withstanding 150 psi internal pressure without leakage or over stressing.
2. Run Diameter: Compatible with outside diameter of pipe on which saddle is installed.
3. Taps: Iron pipe threads.
4. Materials:
   a. Body: Malleable or ductile iron.
   b. Straps: Galvanized steel.
   c. Hex Nuts and Washers: Steel.
   d. Seal: Rubber.

5. Manufacturers and Products:
    a. Smith-Blair; Series 313 or 366.
    b. Dresser; Style 91.

B. Nylon-Coated Iron:

1. Pressure Rating: Capable of withstanding 150 psi internal pressure without leakage or over stressing.
2. Run Diameter: Compatible with outside diameter of pipe on which saddle is installed.
3. Materials:
    a. Body: Nylon-coated iron.
    b. Seal: Buna-N.
    c. Clamps and Nuts: Stainless steel.
4. Manufacturer: Smith-Blair; Style 315 or 317.

2.05 OUTLET/TAPPING SADDLES

A. Materials:

1. Straps: Alloy steel with 3/4-inch threaded ends.
2. Seal: O-Ring SBR rubber gasket.
3. Compatible with ductile iron pipe.

B. Connection: AWWA C110/A21.10 flange.

C. Pressure Rating: Capable of withstanding 250 psi internal pressure without leakage over stressing.

D. Manufacturer and Product: American Ductile Iron; Outlet/Tapping Saddle.

2.06 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.

2.07 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.

2.08 MISCELLANEOUS SPECIALTIES

A. Basket Strainer:

1. Sulfuric Acid Strainer:
   a. Configuration: Single chamber basket, removable from the top of the strainer without the use of tools. Strainer shall have flanged or threaded ends, and be rated at 150 psi. Provide tapped and plugged 1/2-inch drain fitting at the bottom of the casing.
   b. Materials of Construction: PVC casing and cover, Viton O-ring cover seal, and PVC, CPVC, or FRP, 20 mesh basket.
   c. Manufacturers:
      1) Hayward.
      2) Fluidtrol.

B. Safety Equipment:

1. SSH-3, Safety Shower/Eyewash Combination (Frost-proof):
   a. Model: Haws Drinking Faucet Co.; Model 8330FP.
   b. Shower: Stainless steel deluge.
   c. Eyewash: Stainless steel aerated eye/face wash, dust cover, and stainless steel bowl.
   d. Valve: Stainless steel, freeze-proof, stay open with stainless steel push-plates and rods.
   e. Support: Freestanding, 1-1/4-inch stainless steel pipe standard, stanchion, and floor flange.
2. SSH, Safety Shower/Eyewash Combination:
   a. Model: Haws Drinking Faucet Co.; Model 8330.
   b. Shower: Stainless steel deluge.
   c. Eyewash: Stainless steel aerated eye/face wash, dust cover, and stainless steel bowl.
   d. Valve: Stainless steel, freeze-proof, stay open with stainless steel push-plates and rods.
   e. Support: Freestanding, 1-1/4-inch stainless steel pipe standard, stanchion, and floor flange.

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.
4. Gravity Pipe Closures: As specified for pressure pipelines, or concrete closures.
5. 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.

3.03 PIPING EXPANSION

A. Piping Installation: Allow for thermal expansion due to differences between installation and operating temperatures.

B. Expansion Joints:

1. Grooved Joint and Flanged Piping Systems: Elastomer bellows expansion joint.
2. Nonmetallic Pipe: Teflon bellows expansion joint.
3. Screwed and Soldered Piping Systems: Copper or galvanized and black steel pipe expansion compensator, as applicable.
4. Air and Water Service above 120 Degrees F: Metal bellows expansion joint.
5. Pipe Run Offset: Flexible metal hose.

3.04 SERVICE SADDLES

A. Ferrous Metal Piping (except stainless steel): Double-strap iron.

B. Plastic Piping: Nylon-coated iron.

3.05 OUTLET/TAPPING SADDLE

A. Install in accordance with manufacturer’s written instructions.

3.06 COUPLINGS

A. General:

1. Install in accordance with manufacturer's written instructions.
2. Before coupling, clean pipe holdback area of oil, scale, rust, and dirt.
3. Remove pipe coating if necessary to present smooth surface.
4. Application:
    a. Metallic Piping Systems: Flexible couplings, transition couplings, and flanged coupling adapters.

3.07 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.

3.08 PIPE SLEEVES

A. Application:

1. As specified in Section 40 27 00, Process 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.

3.09 SLAB, FLOOR, WALL, AND ROOF PENETRATIONS

A. Applications:

1. Watertight and Below Ground Penetrations:
   a. Wall pipes with thrust collars.
   b. Provide taps for stud bolts in flanges to be set flush with wall face.
2. Nonwatertight Penetrations: Pipe sleeves with seep ring.
3. Existing Walls: Rotary drilled holes.
4. Fire-Rated or Smoke-Rated Walls, Floors or Ceilings: Insulated and encased pipe sleeves.

B. Wall Pipe Installation:

1. Isolate embedded metallic piping from concrete reinforcement using coated pipe penetrations as specified in Section 09 90 00, Painting and Coating.
2. Support wall pipes securely by formwork to prevent contact with reinforcing steel and tie-wires.

3.10 CHEMICAL INJECTOR SYSTEM

A. Install in accordance with manufacturer’s instructions.

3.11 MISCELLANEOUS SPECIALTIES

A. Basket Strainers:

1. Install in accordance with manufacturer’s instructions.
2. Field Quality Control:
   a. Conduct test on each basket strainer.
   b. Test valves shall be tested for proper seating, travel, and operation.
3. Manufacturer’s Services: Provide manufacturer’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, equipment testing, startup assistance, and training of Owner’s personnel for specified component, subsystem, equipment, or system.

B. Safety Equipment:

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 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, hen 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.
3. Water Hammer Arrestors: Install at all emergency safety showers and eyewashes.

END OF SECTION

SECTION 40 27 02
PROCESS VALVES AND OPERATORS

PART 1 GENERAL

1.01 SCOPE AND RESPONSIBILITES

A. Owner has preselected and prenegotiated scope and price for some valves and operators, as indicated in Section 40 99 91, Filter Package Control System, from supplier Industrial Control System, Inc. for Work specified in Section 43 12 01, Compressed Air Systems, Section 40 99 91, Filter Package Control System, and herein.

B. The prenegotiated scope includes, but is not limited to, manufacturing and furnishing equipment and materials, delivering to the jobsite, installation of equipment, testing, providing various documentation, and providing services, as specified herein. The Contractor shall coordinate with the Supplier regarding details of the Supplier's scope.

C. Contractor's responsibilities shall include, but are not limited to, procurement, unloading/ receipt at the jobsite, storage, handling, coordination, and startup.

D. Owner's preselection and prenegotiation shall in no way be construed to change, in any material way, Contractor's responsibilities under the terms and conditions of this Contract.

1.02 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 (1,000 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.

1.03 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. Power and control wiring diagrams, including terminals and numbers.
    e. For each power actuator provided, manufacturer’s standard data sheet, with application specific features and options clearly identified.
    f. Sizing calculations for open-close/throttle and modulating valves.
    g. 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. Manufacturer's Certificate of Compliance, in accordance with Division 01, General Requirements, for:
   a. Electric actuators; full compliance with AWWA C542.
   b. Butterfly valves; full compliance with AWWA C504.
3. Component and attachment testing seismic certificate of compliance as required by Section 01 45 33, Special Inspection, Observation, and Testing.
4. Tests and inspection data.
5. Operation and Maintenance Data as specified in Section 01 78 23, Operation and Maintenance Data.
6. Manufacturer's Certificate of Proper Installation, in accordance with Section 01 43 33, Manufacturers' Field Services.

PART 1 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.

1. 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 Electric Motor Actuated Valve Schedule, Pneumatic Actuated Valve Schedule, and 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. Gate Valves:

1. General:
   a. AWWA gate valves to be in full compliance with stated AWWA standard and the following requirements:
      1) Provide 2-inch operating nut and handwheel for AWWA gate valves 12 inches and smaller.
      2) Provide totally enclosed spur or bevel gear operator with indicator for AWWA gate valves 14 inches and larger.
      3) Provide Affidavit of Compliance per the applicable AWWA standard for AWWA gate valves.
      4) Mark AWWA gate valves with manufacturer’s name or mark, year of valve casting, valve size, and working water pressure.
      5) Repaired AWWA gate valves shall not be submitted or supplied.
      6) Supply AWWA gate valves with stainless steel bolting.
      7) AWWA C509 and AWWA C515 valves may be substituted for each other.
2. Type V132 Resilient Seated Gate Valve 3 Inches to 12 Inches, for Buried Service:
   a. Iron body, resilient seat, bronze stem and stem nut, mechanical joint ends, nonrising stem, in accordance with AWWA C509, 2-inch operating nut, minimum design working water pressure 250 psig, full port, fusion epoxy coated inside and outside per AWWA C550 , NSF/ANSI 61 certified.
   b. Manufacturers and Products:
      1) M&H Valve; AWWA C509.
      2) U.S. Pipe; A-USPO.

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.
   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 V304 Ball Valve 2 Inches and Smaller for General Water and Air Service:
   a. Three-piece, full port, NPT threaded ends, bronze body and end pieces, hard chrome plated solid bronze or brass ball, RTFE seats and packing, blowout-proof stem, zinc-plated steel hand lever operator with vinyl grip, rated 600-pound WOG, 150 psi SWP, complies with MSS SP-110.
   b. Manufacturers and Products:
      1) Threaded Ends:
         a) Conbraco Apollo; 82-100.
         b) Nibco; T-595-Y.
         c) Stockham; T-395 Series.
      2) Solder Ends:
         a) Conbraco Apollo; 82-200.
         b) Nibco; S-595-Y.
         c) Stockham; S-395 Series.
3. Type V309 Instrument Air Shutoff Valve 1/8 Inch to 3/4 Inch:
   a. Stainless steel body ball valve, nylon handle, tube fitting ends, PTFE seats and seals, panel nut, rated 1,500 psi minimum.
   b. Manufacturers and Products:
      1) Swagelok; 40 Series.
      2) Parker Hannifin; B Series.
4. Type V310 Ball Valve for Chlorine Liquid and Gas:
   a. 600-pound WOG, carbon steel body, monel ball and stem, reinforced Teflon seat, Teflon seals, double stem seal, lever operator, screwed ends, nonlubricated, and comply with the requirements of Chlorine Institute Pamphlet 6.
   b. Manufacturer and Product: ITT Camtite.

5. 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.
6. 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. Butterfly Valves:

1. General:
   a. In full compliance with AWWA C504 and following requirements:
      1) Suitable for throttling operations and infrequent operation after periods of inactivity.
      2) Elastomer seats which are bonded or vulcanized to the body shall have adhesive integrity of bond between seat and body assured by testing, with minimum 75-pound pull in accordance with ASTM D429, Method B.
      3) Bubble-tight with rated pressure applied from either side. Test valves with pressure applied in both directions.
      4) No travel stops for disc on interior of body.
      5) Self-adjusting V-type or O-ring shaft seals.
      6) Isolate metal-to-metal thrust bearing surfaces from flowstream.
      7) Provide traveling nut or worm gear actuator with handwheel. Valve actuators to meet the requirements of AWWA C504.
      8) Buried service operators shall withstand 450 foot-pounds of input torque at fully open and fully closed positions.
      9) Provide linings and coatings per AWWA, unless otherwise indicated on Drawings or specified herein.
      10) Valves to be in full compliance with NSF/ANSI 61. Provide NSF/ANSI 61 certificate for each valve.

b. Non-AWWA butterfly valves to meet the following actuator requirements:
   1) For above ground installations, provide handle and notch plate for valves 6 inches and smaller and heavy-duty, totally enclosed gearbox type operators with handwheel, position indicator and travel stops for valves 8 inches and larger, unless otherwise indicated on Drawings or specified herein.

2. Type V500 Butterfly Valve Water Works Service 3 Inches to 72 Inches:
   a. AWWA C504, Class 150B.
   b. Short body type, flanged ends.
   c. Cast-iron body, cast or ductile iron disc, Type 304 stainless steel shafts, Buna-N rubber seat, and stainless steel seating surface.
   d. Provide epoxy lining and coating in compliance with AWWA C550.
   e. Manufacturers and Products:
      1) Pratt; Model 2FII or Triton XR-70.
      2) DeZurik; AWWA Valve.
3. Type V510 Lug Style Butterfly Valve, Resilient Seated, 2 Inches to 20 Inches for Low Pressure Process Air Service:
   a. Lug style cast-iron body, aluminum bronze discs, Type 316 stainless steel one-piece stem, self-lubricating sleeve type bushings, EPDM replaceable resilient seat suitable for operating temperatures up to 250 degrees F, 150 psi working pressure rating, bubble-tight at 50 psi differential pressure, valve body to fit between ASME B16.1 Class 125/150 flanges.
   b. Manufacturers and Products:
      1) Bray Controls; Series 31.
      2) Tyco/Keystone; Model AR2.

D. 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 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.

E. Self-Regulated Automatic Valves:

1. Type V722 PVC Pressure Regulating Valve, 1/2 Inch to 1-1/2 Inches:
   a. Diaphragm operated assembly, spring controlled, in-line pattern, NPT threaded inlet and outlet, 150 psi design pressure.
   b. PVC body, Viton seals and diaphragm, coated stainless steel spring, stainless steel adjusting bolt, locknut, and fasteners.
   c. Designed to regulate downstream pressure closing when pressure reaches setpoint; set pressure adjustable from 5 psi to 50 psi.
   d. Manufacturers and Products:
      1) Plast-O-Matic, Series PR.
      2) Hayward; Pressure Regulator.

F. 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 or Viton backing and with PVDF gas barrier diaphragm, double union design, solvent weld socket 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.

B. Electric Motor Actuators, 480 Volts:

1. General:
   a. Comply with latest version of AWWA C542.
   b. Size to 1-1/2 times required operating torque. Motor stall torque not to exceed torque capacity of valve.
   c. Controls integral with actuator and fully equipped as specified in AWWA C542.
   d. Stem protection for rising stem valves.
2. Actuator Operation—General:
   a. Suitable for full 90-degree rotation of quarter-turn valves or for use on multiturn valves, as applicable.
   b. Manual override handwheel.
   c. Valve position indication.
   d. Operate from FULL CLOSED to FULL OPEN positions or the reverse in the number of seconds given in Electric Actuated Valve Schedule.
   e. Nonintrusive Electronic Control: Local controls, diagnostics, and calibration, including limit and torque settings, shall be accomplished nonintrusively. Electronic valve position display with capability to show continuous torque output. If applicable, provide two hand-held configuration units for every 10 actuators provided, two minimum.
3. Modulating (M) Service:
   a. Size actuators for continuous modulating duty.
   b. Feedback potentiometer, or equivalent, and integral electronic positioner/comparator circuit to maintain valve position.

c. HAND-OFF-AUTO (Local-Off-Remote) Selector Switch, padlockable in each position:
   1) Integral OPEN-STOP-CLOSE momentary pushbuttons with seal-in circuits to control valve in HAND (Local) position.
   2) 4 mA to 20 mA dc input signal to control valve in AUTO (Remote) position.
   3) Auxiliary contact that closes in AUTO (Remote) position.
d. OPEN and CLOSED indicating lights.
e. Ac motor with solid state reversing starter or dc motor with solid state reversing controller, and built-in overload protection. Controller capable of 1,200 starts per hour.
f. Duty cycle limit timer and adjustable band width, or equivalent, to prevent actuator hunting.
g. Valve position output converter that generates isolated 4 mA to 20 mA dc signal in proportion to valve position, and is capable of driving into loads of up to 500 ohms at 24 volts dc.

4. Limit Switch:
   a. Single-pole, double-throw (SPDT) type, field adjustable, with contacts rated for 5 amps at 120 volts ac.
   b. Each valve actuator to have a minimum of two auxiliary transfer contacts at end position, one for valve FULL OPEN and one for valve FULL CLOSED.
   c. Housed in actuator control enclosure.
5. Control Features: Electric motor actuators with features as noted above, and as modified/supplemented in Electric Actuated Valve Schedule.
6. Manufacturers and Products:
   a. Rotork Controls.
   b. Flowserve Limitorque.
   c. AUMA.

C. Pneumatic Actuators:

1. General:
   a. Actuator complete with air sets, exhaust mufflers, speed controls, pilot solenoids, safety vented isolation valves, and accessories.
   b. Suitable for full operation range of valve at air supply pressure indicated.
   c. Position indication and stop limiting devices on all actuators.
2. Vane Style Actuator:
   a. In compliance with AWWA C541.
   b. Air supply of 80 psig.
   c. Pressure die-cast aluminum housing with corrosion resistant fusion bonded epoxy finish, stainless steel bolting, stainless steel adjustable end stops.

d. Electroless nickel-plated steel shaft and vane, single-component machined or cast part.
e. Dual-opposed polyurethane lip seals with stainless steel expander.
f. Double Acting:
    1) Complete with mounting hardware.
    2) Suitable for non-lubrication air.
g. Spring Return:
    1) Wound stainless steel spring type in separate housing.
    2) Attached to pneumatic actuator housing.
h. Geared Manual Override: Geared type with de-clutchable handwheel, torque rated for application.
i. Visual Indicator: High visibility, OPEN-CLOSED indication, color coded, chemical resistant, clear polycarbonate cover.
j. Manufacturers:
    1) K-Tork. No substitution is permitted.

3. Accessories:
    a. Limit Switch:
        1) Single-pole, double-throw (SPDT) type, rated 10 amps at 120 volts ac.
        2) Housed in NEMA 4X enclosure.
        3) Adjustable for OPEN and CLOSED valve positions.
    b. Positioner:
        1) For modulating actuators, shall be pneumatic force balance instruments to control valve position as a function of input signal. Accomplish positive positioning of valve by a mechanical feedback connection from valve actuating mechanism. Position feedback through a characterized linear cam to allow adjustment of valve positioning and input signal. Positioner suitable for double acting or spring return actuator.
        2) Positioner to have zero and span adjustment and be field reversible for direct or reverse action.
        3) Gauges for supply and output pressure and for input signal pressure.
        4) Positioner for 3 psig to 15 psig pneumatic input signal or 4 mA to 20 mA dc input signal as indicated.
        5) Positioner for dc input signal with transducers shall convert electrical signal to appropriate pneumatic signal. Transducer integral with positioner or separate component. If separate, factory mount transducer on pneumatic operator. Line electric power not required for transducer.
        6) Corrosion-resistant enclosures for positioners and transducers to be splash-proof and moisture-proof with gasketed covers.

c. Pilot Solenoid Valve:
   1) Solenoid valve shall pilot control actuator in appropriate configuration for type of open-close actuator being controlled. Double acting actuator shall have four-way solenoid valve, and spring return actuator shall have three-way solenoid valve. Dual coil valve shall not change position unless one coil is energized while the other is de-energized.
   2) Pilot operated diaphragm type solenoid valve with brass body and resilient seat. Valve with minimum operating pressure differential no greater than 10 psig and maximum operating pressure differential no less than 150 psig. Internal parts corrosion-resistant. Solenoid valve to have Class F molded coils for operation on 120 volts ac, 60-Hz, unless otherwise indicated. Solenoid enclosure as defined in NEMA 250, Type 4X.
   3) Manufacturers and Products:
      a) Asco Red Hat.
      b) C. A. Norgren Co.

4. Open-Close and Throttling Valve:
   a. Double Acting Cylinders: Four-way solenoid with dual coils.
   b. Spring Return Cylinders: Three-way solenoids, spring return.
5. Modulating Valve: Positioner with 4 mA to 20 mA input signal, unless otherwise indicated.
6. Control Features: Pneumatic actuators with features noted in the Pneumatic Actuated Valve Schedule.

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 and Drawings.

B. Limit Switch:

1. Factory installed NEMA 4X limit switch by actuator manufacturer.
2. SPST, rated at 5 amps, 120 volts ac.

C. 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, or CHEMICAL.
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.

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. Butterfly Valves:
    a. Unless otherwise restricted or shown on Drawings, install valve a minimum of 8 diameters downstream of a horizontal elbow or branch tee with shaft in horizontal position.
    b. For vertical elbow or branch tee immediately upstream of valve, install valve with shaft in vertical position.

c. For horizontal elbow or branch tee immediately upstream of valve, install valve with shaft in horizontal position.
d. When installed immediately downstream of swing check, install valve with shaft perpendicular to swing check shaft.
e. For free inlet or discharge into basins and tanks, install valve with shaft in vertical position.

4. 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.
5. 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. Install safety isolation valves on compressed air.

G. Locate valve to provide accessibility for control and maintenance. Install access doors in finished walls and plaster ceilings for valve access.

H. Extension Stem for Operator: Where depth of valve operating nut is 3 feet or greater below finish grade, furnish operating extension stem with 2-inch operating nut to bring operating nut to a point within 6 inches of finish grade.

I. Torque Tube: Where operator for quarter-turn valve is located on floor stand, furnish extension stem torque tube of a type properly sized for maximum torque capacity of valve.

J. Floor Box and Stem: Steel extension stem length shall locate operating nut in floor box.

K. Chain Wheel and Guide: Install chain wheel and guide assemblies or chain lever assemblies on manually operated valves over 6 feet 9 inches above finish floor. Install chain to within 3 feet of finish floor. Where chains hang in normally traveled areas, use appropriate "L" type tie-back anchors. Install chains to within operator horizontal reach of 2 feet 6 inches maximum, measured from normal operator standing location or station.

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 SUPPLEMENTS

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

1. Electric Actuated Valve Schedule.
2. Pneumatic Actuated Valve Schedule.

END OF SECTION

Electric Actuated Valve Schedule									
Tag Number	Valve Type	Actuator Power Supply	Valve Size (inches)	Process Fluid	Maximum Operating Flow (gpm)	Maximum ΔP (psi)	Service	Travel Time (Seconds)	Control Feature Modifications/ Supplements
FCV-330	V500	480-volt, three-phase	20	BWS			M	30	
FCV-320	V510	480-volt, three-phase	8	ALP			O/C	30	
FV-300-1,2	V500	480-volt, three-phase	24	FI			O/C	30	
FV-300-3	V500	480-volt, three-phase	24	WWD			O/C	30	

Electric Actuated Valve Schedule									
Tag Number	Valve Type	Actuator Power Supply	Valve Size (inches)	Process Fluid	Maximum Operating Flow (gpm)	Maximum ΔP (psi)	Service	Travel Time (Seconds)	Control Feature Modifications/ Supplements

Service: O/C = Open-Close, T = Throttling, M = Modulating

Control Feature Modifications/Supplements:

A = Actuator shall open valve upon loss of signal.

B = Actuator shall close valve upon loss of signal.

C = Actuator shall remain in last position upon loss of signal.

D = Local OPEN-CLOSE momentary pushbuttons that must be continuously depressed to initiate/maintain valve travel; travel stops when pushbutton is released or when end of travel limit is reached.

E = Remote OPEN-CLOSE maintained dry contacts; travel stops when remote contact opens, or when end of travel limit is reached.

F = Three 24-volt dc interposing relays for remote OPEN-STOP-CLOSE control. Relays powered externally, thereby permitting valve control from greater distances.

G = Motor and control enclosure(s) NEMA 250, Type 4 with 120-volt space heaters.

H = Motor and control enclosure(s) NEMA 250, Type 6 (IP 68) with 120-volt space heaters.

I = Motor and control enclosure(s) NEMA 250, Type 7 with 120-volt space heaters.

J = Valve position output converter that generates isolated 4 mA to 20 mA dc signal in proportion to valve position, and is capable of driving into loads of up to 500 ohms at 24 volts dc.

K = 120-volt secondary control power transformer.

L = Externally operable power disconnect switch.

Pneumatic Actuated Valve Schedule								
Tag Number	Valve Type	Size (inches)	Fluid	Maximum Operating Flow	Maximum ΔP (psi)	Service	Travel Time (Seconds)	Actuator Type and Control Features
FV-30X-1; X=1,2,3,4,5,6,7,8	V500	12	FI			O/C	30	V
FV-30X-2; X=1,2,3,4,5,6,7,8	V500	20	BWS			O/C	30	V
FV-30X-3; X=1,2,3,4,5,6,7,8	V500	8	FTW			O/C	30	V
FV-30X-4; X=1,2,3,4,5,6,7,8	V500	24	WWD			O/C	30	V
FCV-30X-5; X=1,2,3,4,5,6,7,8	V500	12	FE			M	30	V
FV-30X-6; X=1,2,3,4,5,6,7,8	V510	8	ALP			O/C	30	V

Pneumatic Actuated Valve Schedule								
Tag Number	Valve Type	Size (inches)	Fluid	Maximum Operating Flow	Maximum ΔP (psi)	Service	Travel Time (Seconds)	Actuator Type and Control Features

Service: O/C = Open-Close, T = Throttling, M = Modulating

Actuator Type and Control Features:

A = Vane Type Actuator.

B = Cylinder Type Actuator.

C = Diaphragm Type Actuator.

D = Valve shall open upon loss of signal.

E = Valve shall remain in last position upon loss of signal.

FC = Fail Close on loss of air supply (Air to open, spring to close).

FO = Fail Open on loss of air supply (Air to close, spring to open).

G = Positioner with 3 to 15 psig pneumatic input signal.

H = Valve position output converter that generates isolated 4 mA to 20 mA dc signal in proportion to valve position, and is capable of driving into loads of up to 500 ohms at 24 volts dc.

I = Visual indicator.

J = Manual handwheel override.

L = Limit switch.

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; Foamglass One.

2.02 ROOF DRAIN AND OVERFLOW DRAIN SUMP INSULATION

A. Type 1: 1-inch thick.

2.03 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.

2.04 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 that 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, Process 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. Roof Drains: Insulate vertical drops from roof drains to horizontal pipe, exposed and concealed horizontal piping, and 2 feet down on vertical risers from horizontal pipe.

G. Roof Drains and Overflow Drains: Insulate entire pipe runs. Where roof and overflow drains exist through an exterior wall ensure annular space between pipes and walls are properly sealed prior to insulating.

H. Roof Drain and Overflow Drain Sumps: Insulate entire sumps.

I. 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.

J. 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, Process 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. Service and Insulation Thickness Table.

END OF SECTION

Service and Insulation Thickness								
					Finish Systems			
Service Type	Pipe Legend	Thickness	Fluid Temperature (degrees F)*	Insulation	Concealed from View	Indoors Exposed	Outdoors	Buried
HT–Piping requiring heat tracing.		Pipe Size: Insulation Thickness Inches:* 1/4-3: 1 3.5-10: 1.5 12-16: 2 18-24: 2.5		Type 2 Insulate and heat trace outside lines 1' above grade. Use Type 3 insulation from 1' above grade to frost depth.	None	F3 unless otherwise noted	F3	F4 on Type 3

*Use these fluid temperatures unless otherwise noted in the Piping Schedule.
Inches*: Based upon insulation with glass fiber per ASTM C547, outdoors with 20 mph wind with 10 percent safety and no value assigned to cladding or air space at cladding. Matches the watts per foot 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. 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.

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 30 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 PNEUMATIC TEST FOR PRESSURE PIPING

A. Do not perform on:

1. PVC or CPVC pipe.
2. Piping larger than 10 inches.
3. Buried and other non-exposed piping.

B. Fluid: Oil-free, dry air.

C. Procedure:

1. Apply preliminary pneumatic test pressure of 25 psig maximum to piping system prior to final leak testing, to locate visible leaks. Apply soap bubble mixture to joints and connections; examine for leakage.
2. Correct visible leaks and repeat preliminary test until visible leaks are corrected.
3. Gradually increase pressure in system to half of specified test pressure. Thereafter, increase pressure in steps of approximately one-tenth of specified test pressure until required test pressure is reached.
4. Maintain pneumatic test pressure continuously for minimum of 10 minutes and for such additional time as necessary to conduct soap bubble examination for leakage.
5. Correct visible leakage and retest as specified.

D. Allowable Leakage: Piping system, exclusive of possible localized instances at pump or valve packing, shall show no visual evidence of leakage.

E. After testing and final cleaning, purge with nitrogen those lines that will carry flammable gases to assure no explosive mixtures will be present in system during filling process.

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 Filter Magic Control System into the existing Wonderware SCADA system via Ethernet.
   c. Addition of one new PLC control panel (CP-CHEM1) in the existing chemical building that will connect to the existing Horner Electric and Wonderware PLC/SCADA system via Ethernet. Note that this PLC will be used for future projects and should be sized to allow for future I/O expansion.
   d. Integration of vendor provided PLC based PAC system.
   e. Contractor shall coordinate closely with the Filter Control System (FCS) supplier to integrate the new filter control system with the existing plant SCADA system. At a minimum, work with the FCS vendor to provide the following:
      1) Establish an Ethernet connection between the new FSC and the existing plant SCADA server.
      2) Remove all data from existing SCADA server related to the existing filter controls (existing graphic screens are to remain).
      3) Set up Read/Write data from the FCS with the existing PLC in order to show data on the existing graphic screens.
   f. 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.
   g. Application software shall be provided by the Contractor. Work includes but is not limited to, programming of the new PLC provided under this section or of other PICS subsystem sections, 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. Industrial Control Systems, Inc., Sandstone, VA.
2. M/R Systems, Norcross, GA.
3. Revere Control Systems, Birmingham, AL.
4. J.K. Duren Company, Roswell, GA.
5. Transdyn, Inc., Duluth, GA.

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.

11. Fiber Optic Cable Site Layout Diagrams Showing:
a. Access holes, with identification.
b. Abovegrade cable routings, with pole and cable identification.
c. Belowgrade conduit routings between access holes and buildings, with conduit counts and identification.
d. Belowgrade innerduct routings through conduits, with innerduct counts and identification.
e. Cable routings through innerducts and to patch panels, fiber centers, or network nodes, with cable and node identification.

12. Fiber Cable Schedule Showing:
a. Cable identification.
b. Fiber counts for each cable and identification of used fiber pairs.

c. Cable length and attenuation, with connector pairs and patch cords, based on TIA 568-C.3, Annex H. Calculations to show the following:
   1) Light emitter/receiver power budget in dB.
   2) Attenuation due to cable for each path.
   3) Attenuation due to connector loss.
   4) Attenuation due to patch cable loss.
   5) Reserve light budget required for each device.
   6) Total attenuation for each path.
   7) Total remaining light budget for each path minus any recommended reserve light budget.

13. Block diagram showing all fiber cable interconnections and routing.
14. Fiber Optic Cable Component Data:
    a. Manufacturer and model number.
    b. General data and description.
    c. Engineering specifications and data sheet.
15. Installation Details: Include modifications or further details required to adequately define installation of I&C components.
16. List of spares, expendables, test equipment and tools.
17. Additional Equipment Recommended: List of, and descriptive literature for, additional spares, expendables, test equipment and tools recommended. Include unit prices and total costs as specified in Section 01 29 00, Payment Procedures.

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.
4. Manufacturer’s statement that installer is certified to perform installation Work for fiber optic cables.
5. Subcontractor Qualifications:
   a. FOCS Subcontractor: Minimum of 5 years’ experience providing, integrating, installing, and commissioning of similar systems.
      1) Statement of Experience: List of at least three fiber optic data communications systems comparable to system specified which have been furnished and placed into operation. For each system, provide following information:
         a) Owner’s name, address, telephone number, and name of current operations supervisor or other contact.

b) Description of system hardware configuration, including major equipment items, number of nodes, and communication standards implemented.
c) System block diagram.
d) Dates when contract was signed, equipment was delivered, and system was accepted by Owner. Also, include originally scheduled completion date and if different from actual date, explain why.
e) Approximate value of listed FOCS provided in dollars.
f) Detailed horizontal and riser routing.
g) Distribution frame arrangements.
h) Fiber and termination identification, including spares.

b. FOCS Subcontractor's Site Representative: Minimum of 5 years' experience installing similar systems.
c. Qualification of Personnel:
   1) Resumes identifying management and technical qualifications of supervisory, local service representative, and key personnel.
   2) Qualification data of firm and persons to demonstrate capabilities and experience in the following areas:
      a) Fiber optic cable handling and placement techniques.
      b) Fiber optic splicing and installation of connections.
      c) Attenuation testing procedures.
d. Owner acceptance of FOCS Subcontractor does not exempt FOCS Subcontractor or Contractor from meeting Contract Document requirements nor does it give prior acceptance of subsystems, equipment, materials, or services.
e. Sample of Network Test Report, minimum ten pages, that Contractor generated in a previous project.
f. Testing and acceptance plan, 30 days prior to beginning of testing.
g. Fiber Test Results: Documentation covering fiber facility testing, not later than 2 days after testing, showing:
   1) Manufacturer's tag of attenuation per fiber as recorded from OTDR reading before shipment.
   2) Attenuation of each fiber upon delivery to Site.
   3) Attenuation of each fiber plus connector after installation as recorded from OTDR with tracing.
   4) Flux budget calculations with comparison to measured attenuation for each run verifying adequate optical signal strength. Include optical device manufacturer's optical light reserve margin in calculations, use 3dB if manufacturer does not have a recommend light budget reserve.

6. Fiber Optic Cable Manufacturer’s Certificate of Proper Installation.
7. Fiber Optic Cable Manufacturer’s suggested installation practice.
8. Operation and Maintenance Data: As specified in Section 01 78 23, Operations and Maintenance Data.

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.

C. Fiber Optic Manufacturer Qualifications:

1. Cable:
   a. ISO 9001 or QF TL 9000 registered, whichever applies to material.
   b. Minimum of 20 years in manufacturing optical fiber cable in order to demonstrate reliable field performance.
2. Housing: ISO 9001 and QF TL 9000 registered.
3. Connector:
   a. ISO 9001 or QF TL 9000 registered.
   b. Minimum 10-year history of manufacturing and supporting connector technology that does not require epoxy or polishing in field.
4. Jumper Cable: ISO 9001 and QF TL 9000 registered.

D. Installer Qualifications:

1. Individuals with at least 3 years of experience with projects utilizing fiber optic cable in compliance with TIA 568-C.3.
2. Certified by fiber cable manufacturer.

E. Tester Qualifications: Individuals with at least 3 years of experience with projects utilizing fiber optic cable in compliance with TIA 568-C.3.

1. Technician: Successfully attended training program, which includes testing with an OLTS and an OTDR and have obtained a certificate as proof thereof. Certificate may have been issued by the following organizations or an equivalent organization:
   a. Manufacturer of fiber optic cable and fiber optic connectors.
   b. Manufacturer of test equipment used for field certification.
   c. Other independent training organizations acceptable to Owner.

F. Provide connectors/coupling, splicing enclosures, mounting hardware, and miscellaneous accessories for fibers by same manufacturer.

1.06 SPECIAL GUARANTEE, FIBER OPTIC CABLE

A. Provide manufacturer’s extended guarantee or warranty, with Owner named as beneficiary, in writing, as special guarantee. Special guarantee shall provide for correction, or at option of Owner, removal and replacement of Work specified in this section found defective during a period of 5 years after date of Substantial Completion. Duties and obligations for correction or removal and replacement of defective Work shall be as specified in General Conditions.

1.07 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.

1.08 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.

C. Optical Fiber Cable and Cable Splice Centers:

1. Outside, Underground/Submerged: Minus 20 degrees C to 40 degrees C.
2. Outside, Overhead: Minus 40 degrees C to 80 degrees C.
3. Outside, Aboveground in Conduit: Minus 40 degrees C to 80 degrees C.
4. Inside: 0 degree C to 40 degrees C.

1.09 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.

Activity	Prerequisites and Lead Times
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.

1. 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 groves 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

Tag Function	Inscription(s)	Color
OCA	OPEN CLOSE AUTO	Black Black Black
OOA	ON OFF AUTO	Black Black Black
MA	MANUAL AUTO	Black Black
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 MULTIMODE FIBER OPTIC CABLE

A. General 62.5-micron, graded-index for use in backbone and horizontal distribution subsystems, meets or exceeds the requirements of TIA 568-C.3, including the following specifications:

1. Maximum Mean Fiber Loss:
   a. 3.5 dB per km at 850 nm.
   b. 1.5 dB per km at 1,300 nm.
2. Minimum OFL Bandwidth:
   a. OM1-200 MHz•km minimum at 850 nm; TIA 492AAAB.
   b. 500 MHz•km minimum at 1,300 nm.
3. Distance Capacity per IEEE 802.3:
   a. 100Mbit Ethernet: OM2300m at 850 nm and 2000m at 1,310 nm.
   b. 1 gbit Ethernet:
      1) OM1: 300m at 850 nm and 550 at 1,310 nm.
   c. 10 gbit Ethernet—10km at 850 nm and 40km at 1,310 nm:
      1) OM1: 33m at 850 nm and 300 at 1,310 nm.

B. Type 62.5 OM1, Indoor/Outdoor Cable, requirements in addition to general requirements above:

1. Individual Fibers: 62.5/125/250/900 microns.
2. Assembly:
   a. Distribution Style with core of individually tight-buffered fibers surrounded by nonmetallic sheath.
   b. Cable: Comply with ICEA S-83-596.
3. Protective Covering: Flame retardant, oil resistant, chemical resistant, and water resistant fluoropolymer outer jacket.
4. NEC/UL Listing: OFNP.
5. Manufacturers and Products:
   a. Corning Freedm One Riser Cables.
   b. Corning Freedm One Plenum Cables.
   c. No substitutes.

2.06 FIBER OPTIC CONNECTORS

A. General:

1. Connect all fibers and terminate at equipment and patch panels.
2. Comply with TIA/EIA 604-2, TIA/EIA 604-3, TIA/EIA 604-12, and TIA 568-C.3.
3. SC connectors or as required for proper mating connection.
4. Pull Strength: 0.2 N minimum.

5. Durability: Sustain minimum 500 mating cycles without violating other requirements.
   a. Ferrules: Free-floating low loss ceramic.
   b. Polarizing key on duplex connector systems.
6. Attenuation:
   a. In accordance with TIA 568-C.3.
   b. Maximum of 0.5 dB per connector pair.
7. Manufacturers:
   a. Corning.
   b. Ortronics.
   c. AMP Netconnect.

2.07 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
Terminal Blocks	10	10
Hand Switches	10	5

2.08 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.

2.09 CORROSION PROTECTION

A. Corrosion-Inhibiting Vapor Capsule Manufacturers:

1. Northern Instruments; Model Zerust VC.
2. Hoffmann Engineering Co; Model A-HCI.

2.10 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.

2.11 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 assembles, 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 form 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 inflame 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 FIBER OPTIC CABLE INSTALLATION

A. Fiber Optic Cable:

1. Specified fiber counts, routing, origination, and terminating points are indicated on Drawings.
2. Installation by manufacturer's certified installer.
3. Install cables in accordance with manufacturer's requirements.
4. Install cable directly from shipping reels. Ensure that cable is:
   a. Not dented, nicked, or kinked.
   b. Not subjected to pull stress greater than manufacturer's specification.
   c. Not bent to a radius below manufacturer's minimum bend radius.
   d. Not subjected to treatment that may damage fiber strands during installation.
5. Cables per Innerduct: One cable maximum.
6. If calculation indicates cable will attenuate signals more than 8 dB, reroute may be allowed if approved by Engineer.
7. Connector: Insertion loss on multimode connections exceeding 0.5 dB and 0.4 dB on single-mode connections not permitted.
8. Identification:
   a. Identify cable on both ends, in access holes, and pull points.
   b. In accordance with TIA 606.
9. Arrange cable, equipment, and hardware to provide neat appearance and accessibility for servicing.
10. Access Holes:
    a. Provide supports for cables in access and handholes at minimum 24 inches.
    b. While maintaining minimum bend radius, lace cables neatly to supports to keep them out of way of personnel.

B. Cable Terminations:

1. In accordance with TIA 568-C.3.
2. Fan out fiber cable to allow direct connectorization of connectors.
   a. Sleeve over individual fibers with transparent furcation tubes.
   b. At point of convergence of furcation tubes, provide strain relief with metal or high density plastic fan-out collar.
3. Break-out Kits:
   a. Terminate cables using manufacturer-supplied break-out kits.
   b. Terminate in accordance with manufacturer's recommendations.
4. Slack:
   a. Fiber Centers, Hubs, and Switches: Minimum, 3-meter slack fiber at each end, coiled neatly in cable management equipment.
   b. Communications Management Outlets: Minimum, 1-meter slack fiber, coiled neatly in outlet box.
5. Connectors:
   a. Terminate 100 percent fibers in each cable to specified connector.
   b. Connect into fiber management system.

3.04 FIELD QUALITY CONTROL FIBER OPTIC CABLE

A. General:

1. Advise Engineer at least 48 hours in advance of each test. Engineer shall have option to witness and participate actively in tests.
2. In accordance with Division 01, General Requirements.
3. Provide equipment, instrumentation, supplies, and skilled staff necessary to perform testing.
4. Outlets, cables, patch panels, and associated components shall be fully assembled and labeled prior to field testing.
5. Testing performed on incomplete systems shall be redone on completion of the Work.
6. Document Test Results: Confirm each cable has at least specified number of fibers that meet standards, in accordance with As-Built Fiber Optic Cable Installation form included as Supplement to this section.
7. Confirm quantities and sizes of conduit and innerduct, in accordance with As-Built Conduit/Innerduct Installation form included as Supplement to this section.

B. Test Equipment:

1. Field test instruments shall have latest software and firmware installed.
2. Optical Fiber Cable Testers:
   a. Field test instrument shall be within calibration period recommended by manufacturer.

b. Optical Loss Test Set (OLTS):
   1) Multimode Optical Fiber Light Source:
      a) Provide dual LED light sources with central wavelengths of 850 nm (plus or minus 30 nm) and 1,300 nm (plus or minus 20 nm).
      b) Output Power: Minus 20 dBm minimum.
      c) Meet launch requirements of TIA/EIA 455-78. This launch condition can be achieved either within the field test equipment or by use of an external mandrel wrap, as described in Clause 11 of TIA 568-C.3, with Category 1 light source.
      d) Manufacturer: Fluke Networks.
   2) Power Meter:
      a) Provide 850 nm, 1,300/1,310 nm, and 1,550 nm wavelength test capability.
      b) Power Measurement Uncertainty: Plus or minus 0.25 dB.
      c) Store reference power measurement.
      d) Save at least 100 results in internal memory.
      e) PC interface (serial or USB).
      f) Manufacturer: Fluke Networks.
   3) Optional Length Measurement: Capable of measuring optical length of fiber using time-of-flight techniques.

3. Optical Time Domain Reflectometer (OTDR):
   a. Bright, color transmissive LCD display with backlight.
   b. Rechargeable for 8 hours of normal operation.
   c. Weight with battery and module of not more than 4.5 pounds and volume of not more 200 cubic inches.
   d. Internal nonvolatile memory and removable memory device with at least 16 MB capacity for results storage.
   e. Serial and USB ports to transfer data to PC.
   f. Multimode OTDR:
      1) Wavelengths: 850 nm (plus or minus 20 nm) and 1,300 nm (plus or minus 20 nm).
      2) Event Dead Zone: 1 meter maximum at 850 nm and 2 meters maximum at 1,300 nm.
      3) Attenuation Dead Zone: 6 meters maximum at 850 nm and 15 meters maximum at 1,300 nm.
      4) Distance Range: 2,000 meters minimum.
      5) Dynamic Range: Minimum 10 dB at 850 nm and 1,300 nm.
   g. Manufacturer: Fluke Networks.
4. Fiber Microscope:
   a. Magnification: 250X or 400X for end-face inspection.
   b. Manufacturer: Fluke Networks.

5. Integrated OLTS, OTDR, and Fiber Microscope:
    a. Test equipment that combines into one instrument such as OLTS, OTDR, and fiber microscope may be used.
    b. Manufacturer: Fluke Networks.

C. Conduit Test:

1. Test and seal spare conduits.
2. Conduit and Innerduct Testing:
    a. Blow full-diameter mouse through each spare conduit and innerduct to verify they are unrestricted over full length.
    b. If conduit is restricted over full length, advise Engineer.
3. Documentation: Confirm conduit test As-Built Conduit/Innerduct Installation form documentation includes details of innerducts.

D. Cable Testing:

1. Test procedures and field test instruments shall comply with applicable requirements of:
    a. LIA Z136.2.
    b. TIA/EIA 455-78.
    c. TIA/EAI 455-133.
    d. TIA 526-7.
    e. TIA 526-14.
    f. TIA 568-C.1.
    g. TIA 568-C.3.
    h. TIA TSB 140.
2. Test attenuation and polarity of installed cable plant with OLTS and installed condition of cabling system and its components with OTDR.
3. Verify condition of fiber end face.
4. Perform on each cabling link (connector to connector).
5. Perform on each cabling channel (equipment to equipment).
6. Do not include active devices or passive devices within link or channel other than cable, connectors, and splices. For example, link attenuation does not include such devices as optical bypass switches, couplers, repeaters, or optical amplifiers.
7. Document Tests:
    a. OLTS dual wavelength attenuation measurements for multimode links and channels.
    b. OTDR traces and event tables for multimode links and channels.

E. Fiber Testing Parameters:

1. Each cabling link shall be in compliance with the following test limits:
   a. Optical Loss Testing:
      1) Backbone (single-mode and multimode) Link:
         a) Calculate link attenuation by the formulas specified in TIA 568-C.1.
         b) Values for Attenuation Coefficient (dB/km) are listed in the table below:

Attenuation Coefficient				
Type of Optical Fiber	**Wavelength (nm)**	**Attenuation Coefficient (dB/km)**	**Wavelength (nm)**	**Attenuation Coefficient (dB/km)**
Multimode 50/125 µm	850	3.5	1300	1.5

   b. OTDR Testing:
      1) Reflective Events: Maximum 0.75 dB.
      2) Nonreflective Events: Maximum 0.3 dB.
   c. Magnified Endface Inspection:
      1) Visually inspect fiber connections for end-face quality.
      2) Scratched, pitted, or dirty connectors shall be diagnosed and corrected.

F. Diagnosis and Correction:

1. Installed cabling links and channels shall be field tested and pass test requirements and analysis as described herein.
2. Link or channel that fails these requirements shall be diagnosed and corrected.
3. Document corrective action and follow with new test to prove corrected link or channel meets performance requirements.
4. Provide final and passing result of tests for links and channels.

G. Acceptance: Acceptance of test results shall be given in writing after Project is tested and completed in accordance with Contract Documents and satisfaction of Owner.

H. Test Execution:

1. Optical Fiber Cable Testing:
   a. Tests performed that use laser or LED in test set shall be carried out with safety precautions in accordance with LIA Z136.2.

b. Link and channel test results from OLTS and OTDR shall be recorded in test instrument upon completion of each test for subsequent uploading to a PC in which administrative documentation may be generated.
   1) Record end-face images in memory of test instrument for subsequent uploading to a PC and reporting.
c. Perform Testing:
   1) On each cabling segment (connector to connector).
   2) On each cabling channel (equipment to equipment).
   3) Using high-quality test cords of same fiber type as cabling under test.
      a) Test cords for OLTS testing shall be between 1 meter and 5 meters in length.
      b) Test cords for OTDR testing shall be approximately 100 meter for launch cable and at least 25 meters for receive cable.

2. Optical Loss Testing (OLTS):
   a. Backbone Link:
      1) Test multimode at 850 nm and 1,300 nm in accordance with TIA 526-14A, Method B, One Reference Jumper or equivalent method.
      2) Perform tests in both directions.
3. OTDR Testing:
   a. Test backbone, horizontal, and centralized links at appropriate operating wavelengths for anomalies and to ensure uniformity of cable attenuation and connector insertion loss.
      1) Multimode: 850 nm and 1,300 nm.
   b. Test each fiber link and channel in one direction.
   c. Install launch cable between OTDR and first link connection.
   d. Install receive cable after last link connection.
4. Length Measurement:
   a. Record length of each fiber.
   b. Measure optical length using OLTS or OTDR.
5. Polarity Testing:
   a. Test paired duplex fibers in multifiber cables to verify polarity in accordance with subclause 10.3 of TIA/EIA 568-C.1.
   b. Verify polarity of paired duplex fibers using OLTS.
6. Test Results Documentation:
   a. Test results saved within field-test instrument shall be transferred into Windows-based database utility that allows for maintenance, inspection, and archiving of test records. These test records shall be uploaded to the PC unaltered. For example, “as saved in the field-test instrument.” The file format, CSV (comma separated value), does not provide adequate protection of these records and shall not be used.

b. Available for inspection by Owner or Owner's representative during installation period. Submit within 5 working days of completion of tests on cabling served by a telecommunications room or of backbone cabling.
c. Database for project, including twisted-pair copper cabling links, if applicable, shall be stored and delivered on CD-ROM prior to Owner acceptance of building. CD-ROM shall include software tools required to view, inspect, and print test reports.
d. Circuit IDs reported by test instrument shall match specified label identification.
e. Provide in electronic database for each tested optical fiber with the following information:
    1) Identification of Site.
    2) Name of test limit selected to execute stored test results.
    3) Name of personnel performing test.
    4) Date and time test results were saved in memory of tester.
    5) Manufacturer, model, and serial number of field test instrument.
    6) Version of test software and version of test limit database held within test instrument.
    7) Fiber identification number.
    8) Length for Each Optical Fiber: Optionally the index of refraction used for length calculation when using a length capable OLTS.
    9) Test results to include OLTS attenuation link and channel measurements at appropriate wavelength and margin; difference between measured attenuation and test limit value.
    10) Test results to include OTDR link and channel traces, and event tables at appropriate wavelength.
    11) Length for each optical fiber as calculated by the OTDR.
    12) Overall pass/fail evaluation of link-under-test for OLTS and OTDR measurements.

3.05 FIELD FINISHING

A. Refer to Section 09 90 00, Painting and Coatings.

3.06 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.

3.07 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.

3.08 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.

3.09 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.

3.10 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.
8. As-Built Fiber Optic Cable Installation Form.

END OF SECTION

COMPONENT SPECIFICATIONS

A. A152 Particle Counter, Element and Transmitter:

1. General:
   a. Function: Online particle counting.
   b. Type: Laser illumination/light extinction.
   c. Parts: Sensor (element), transmitter and operator interface software.
2. Performance:
   a. Better than 3:1 signal to noise ratio at 2 microns.
   b. Coincidence limit less than 10 percent at 15,000 particles/ml.
   c. Operating Temperature: 35 to 130 degrees F.
3. Sensor/Element:
   a. External of transmitter.
   b. Solid state laser diode.
   c. Flow Cell: 1 mm by 1 mm, coated aluminum.
   d. Viewing Window: Sapphire.
   e. Dynamic Range: 2 to 400 microns.
   f. Sample Flow Rate: 100 ml per minute.
   g. Sample Head: 20 inches, minimum.
4. Transmitter:
   a. Features:
      1) Backlit LCD display.
         a) Diagnostics.
         b) Eight different size particle count channels.
      2) 32-bit microprocessor.
   b. Enclosure:
      1) Suitable for wall mounting.
      2) NEMA 4X polycarbonate.
      3) Dimensions: 15W by 13H by 6D inches, nominal.
   c. Signal Interface:
      1) 4 to 20 mA dc isolated analog outputs.
         a) Quantity: Four.
         b) Each scalable within ranges of 0 to 200 counts per minute, 0 to 2,000 counts per minute, and 0 to 20,000 counts per minute.
      2) Discrete Input: Represents filter backwash event; data shall be tagged accordingly.
   d. Power: 115V ac, 3-wire grounded.
   e. Integral surge protection.
5. Accessories:
   a. Operator Interface Software:
      1) IBM PC compatible.

2) Collects, displays, and stores data.
3) Provides alarm and diagnostic information.
4) Creates scheduled and on demand reports.
5) Four Primary Screens: Graphs, Sensors, Lists, and Alarms.
6) Quantity: One copy per project.
7) Product: Tracware Particle Counter System Software for Windows.

6. Manufacturer and Product: Chemtrac; Particle Counting System, Model PC2400 D.

B. F19 Flow Element, Short Form Venturi:

1. General:
   a. Function: Provide differential pressure signal proportional to square of flow rate.
   b. Type:
      1) Differential pressure producers.
      2) Cast iron flanged line-size device.
2. Service:
   a. Process Fluid: Water, unless otherwise noted.
   b. Process Fluid Temperature: Minus 60 degrees F to 400 degrees F, unless otherwise noted.
   c. Process Pressure: As noted.
   d. Application: As noted.
3. Performance:
   a. Process Flow Range: As noted.
   b. Pressure Differential at Full Scale Flow: Approximately as noted.
   c. Maximum Nonrecoverable Head Loss at Flow:
      1) Approximately as noted.
      2) Nominally not to exceed 10 percent of maximum pressure differential.
   d. Accuracy (Excluding Secondary Instrument Inaccuracy): Plus or minus 0.50 percent of actual reading, uncalibrated, unless otherwise noted.
   e. Compliant with ASME fluid meter codes MFC-3M-1985, ISO 5167, and BS-7045.
4. Supporting Calculations: Using actual line size, provide comprehensive calculations, including (but not limited to):
   a. Pressure differential/flow calculations.
   b. Nonrecoverable head loss calculations.
   c. Reynolds number analysis.
   d. Flashing/cavitation analysis.
   e. For installations in which transmitter is above meter centerline, verify both high and low pressure ports on transmitter are below hydraulic grade line.

5. Features:
    a. Materials:
        1) Body: Cast iron, ASTM A126, Grade B, unless otherwise noted.
        2) Throat: Tap Sleeves: Type 304 or Type 316 stainless steel, unless otherwise noted.
    b. Painting:
        1) Interior: NSF 61 rated.
        2) Exterior: Factory primer.
        3) Nameplate: Permanent stainless steel engraved with tag number, pipe inside diameter, throat inside diameter, flange size, pressure rating, and flow direction.
        4) Available Beta Ratios (Nominal): 0.50, 0.60, and 0.70, plus custom beta ratios
6. Process Connections:
    a. Line Size: As noted.
    b. Connection Type:
        1) Flanged ends.
        2) Flange Rating:
            a) ANSI 150 pound, unless otherwise noted.
            b) Hydrostatic pressure test at least 1-1/2 times the service pressure, as per code.
    c. For installations in which transmitter is above meter centerline:
        1) Call out vertical distance transmitter is above meter center line: As noted.
        2) Used in supporting calculation above.
7. Pressure Tap Connections:
    a. Two high pressure taps, 3/4-inch NPT.
    b. Two low pressure taps, 3/4-inch NPT.
    c. Vent/drain holes, 3/4-inch NPT.
8. Manufacturers and Products:
    a. Primary Flow Signal; Model HVT-CI.
    b. BIF; UVT Model 20181.

C. 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.

D. 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.

E. P3 Pressure Differential Transmitter:

1. General:
   a. Function:
      1) Measure differential pressure.
      2) Transmit signal proportional to differential pressure or square root of differential pressure, as applicable.
   b. Type:
      1) Electronic variable capacitance or silicon strain gauge.
      2) Two-wire transmitter; “smart electronics”.
   c. Parts: Transmitter and accessories.
2. Performance:
   a. Range: As noted.
      1) Select transmitter’s factory upper range limit (URL) such that upper boundary of noted range is as close as possible to 80 percent of factory URL, but does not exceed it.
   b. Accuracy: Plus or minus 0.10 percent of span, unless otherwise noted.
   c. Ambient Operating Temperature: Minus 40 degrees F to plus 175 degrees F, with integral meter.
   d. Process Operating Temperature: Minus 40 degrees F to plus 250 degrees F.
   e. Humidity: 0 to 100 percent relative humidity.
   f. Hazardous Location Certifications: If and as noted.
3. Features:
   a. Linear or square-root output, user-configurable.
   b. Factory preconfigure for square root output if transmitter tagged as “FT” or “FIT”.
   c. Adjustable damping.
   d. LCD indicator, unless otherwise noted.
      1) Display in either percent or engineering units, field configurable.
   e. Wetted Metallic Parts: Type 316 stainless steel, unless otherwise noted.
      1) Includes drain/vent valves; process flanges and adapters, and process isolating diaphragm.

f. Wetted O-Rings: Glass-filled TFE, graphite-filled PTFE, or Viton, unless otherwise noted.
g. Bolts and Nuts (if required): Type 316 stainless steel, unless otherwise noted.
h. Fill Fluid: Silicone, unless otherwise noted.

4. Process Connections:
   a. Line Size: 1/2 inch.
   b. Connection Type: FNPT.
   c. Direct/remote Diaphragm Seal: If and as noted.
5. Signal Interface:
   a. 4 mA to 20 mA dc output with digital signal based on HART protocol, unless otherwise noted below.
      1) Nominal Maximum Loop Resistance with External 24V dc Power Supply: 550 ohms.
   b. FOUNDATION Fieldbus Protocol: If noted.
   c. Profibus: If noted.
6. Enclosure:
   a. Type: NEMA 4X.
   b. Materials: Coated aluminum, unless otherwise noted.
   c. Mounting bracket, unless otherwise noted.
      1) Bracket and Accessories: Stainless steel; suitable for mounting transmitter to panel or 2-inch pipe.
7. Accessories:
   a. Three-valve manifold, unless otherwise noted.
      1) Includes one equalization and two isolation valves.
      2) Type 316 stainless steel.
8. Manufacturers and Products:
   a. Rosemount; Model 3051 CD.
   b. Foxboro; Model IDP10.

F. Y40 Uninterruptible Power Supply System:

1. General:
   a. Function: Provides isolated, regulated uninterrupted ac output power during a complete or partial interruption of incoming line power.
   b. Major Parts: Inverter, a battery charger, sealed battery.
2. Performance:
   a. Capacity: As noted.
   b. Input Power:
      1) 120V ac, single-phase, 60-Hz, unless otherwise noted.
      2) Connections: As noted.
   c. Output Power:
      1) 120V ac, single-phase, 60-Hz, unless otherwise noted.
      2) Connections: As noted.

d. On-line Efficiency: 85 percent minimum, unless otherwise noted.
e. Backup Runtime:
    1) Full Load: 9 minutes minimum, unless otherwise noted.
    2) Half Load: 24 minutes minimum, unless otherwise noted.
f. Continuous no-break power with no measurable transfer time.
g. Sine-Wave Output Power Regulation:
    1) Plus or minus 5 percent or less total harmonic distortion.
    2) Meet or exceed CSA C22.2 No. 107.1 for harmonic distortion.
h. Voltage Regulation: Plus or minus 3 percent nominal.
i. Operating Temperature: 0 to 40 degrees C (32 to 104 degrees F).
j. Lightning and Surge Protection:
    1) Pass lightning standard ANSI/IEEE C62.41 Categories A and B test.
    2) 2,000 to 1 attenuation of input spike.
k. Isolation:
    1) True separately derived power source as per NEC Article 250-5d with output neutral bonded to ground.
    2) Complete from line.
    3) Less than 2 pF effective input to output capacitance.

3. Features:
    a. Bypass Switches: As noted.
    b. Enclosure: Floor-mounted cabinet, unless otherwise noted.
    c. RS232 external interface with full-duplex output capable of:
        1) Remote monitoring of meter functions and alarm conditions.
        2) Remote diagnostic testing.
        3) Remotely set point display and adjustment.
4. Manufacturers:
    a. Best Power, FERRUPS Uninterruptible Power System.
    b. Controlled Power.

G. Y555 PLC/RIO (Including Ancillaries):

1. General:
    a. Function: Multiloop analog and discrete control.
    b. Type:
        1) Programmable Logic Controller (or Remote I/O Drop).
        2) Fully isolated analog input and output modules.
        3) 10 BaseT Ethernet communication between PLC and Plant Control System.
    c. Parts: PLC Processor (or Remote I/O Drop), I/O Chassis, Power Supply Cabling, I/O Modules, Communication Interface Modules (CIM), and specialty modules.

2. Service:
    a. Operating Shock: 30g peak acceleration for 11 ms duration.
    b. Vibration: 2.0 g maximum peak acceleration between 10- to 500-Hz.
    c. Environmental:
        1) Operating Temperature: 32 to 140 degrees F.
        2) Relative Humidity: 5 to 95 percent (without condensation).
3. Type: PLC Processor, unless otherwise noted.
    a. If PLC Processor noted, 1.5 M RAM, unless otherwise noted.
4. PLC Processor:
    a. Features:
        1) Symbolic Addressing (IEC 1131-3 compliant).
        2) Ladder and function block diagram programming languages.
        3) Multiple processors can share common input data.
        4) Pre-emptive multitasking operating system.
        5) Advanced instruction set including file handling, sequencer, diagnostic, shift register, program control, ASCII, function blocks, and motion control instructions.
        6) Scheduled I/O data transfers.
        7) 128,000 I/O max in any mix (4,000 analog I/O max).
        8) Supports both Local I/O and Universal remote I/O.
        9) Supports DeviceNet, ControlNet, and Ethernet/IP communications.
    b. Memory: Battery-backed static RAM.
    c. Program Scan Time/K Instructions: 0.08 ms (Boolean).
    d. ControlNet I/O Scan Time/Chassis: 0.5 ms (typ).
5. I/O Chassis:
    a. Provide at least four spare slots.
    b. Provide slot filter for each unused slot.
    c. Provide all interconnect cable between chassis.
6. Power Supply Modules: Quantity and type as required to power all modules.
7. I/O Modules:
    a. Provide I/O modules to meet the functional requirements. Provide at least 20 percent spare I/O points per each I/O Type: DI, DO, AI, AO.
    b. Removable Terminal Blocks for each module.
    c. Unless otherwise noted, provide modules of the following type:
        1) Discrete Input Modules:
            a) General-purpose individually isolated 120V ac.
            b) 16 points maximum.
        2) Discrete Output Modules:
            a) Individually isolated contacts.
            b) NO.

c) 16 points, maximum.

3) Analog Input Modules:
   a) 4 to 20 mA dc.
   b) Isolated inputs.
   c) 25 ms min, 16-bit floating point resolution.
   d) “IF6I” Module.
4) Analog Output Modules:
   a) 4 to 20 mA dc.
   b) Isolated outputs.
   c) 25 ms, min, 13-bit resolution.

8. Communications Interface Modules (CIM), unless otherwise noted, provide the following CIM and all needed software:
   a. Ethernet Module (ENBT):
      1) Communication Rate: 10 Mbps.
      2) Single-port.
      3) Quantity: One, unless otherwise noted.
9. Specialty Modules:
   a. Fiber Optic Communication Modules.
      1) Fault tolerant, self-healing ring.
      2) Communicates up to 16 miles with multimode fiber.
      3) Backplane Ethernet Connectivity.
      4) Manufacturer and Product: Phoenix Digital Fiber Optic Communication Module.
      5) Quantity: One, unless otherwise noted.
10. Programming Software:
   a. Processor, CIM, and I/O Modules:
      1) Ladder diagram and function block diagram.
      2) Supports the Following Processors: ControLogix, CompactLogix and MicroLogix.
      3) Product: RS Logix Professional.
      4) Quantity: One total for Contract.
11. Manufacturer and Product: Allen Bradley CompactLogic with Ethernet connection (or associated RIO drop) with matching I/O Subsystem.

END OF COMPONENT SPECIFICATIONS

INSTRUMENT AND CONTROL PANEL LIST						
Tag Number	**Comp Code**	**Component Title**	**Options**	**P&ID**	**Inst. Detail**	**Panel No.**
FP-622-1	N/A	Sulfuric Acid Fill Panel	NEMA 4X 316SS Max Allowable Dimensions: 4'H x 3'W x 1'D	I-02	4091-383	
LE/LIT-622-1	L5	Level Element and Transmitter: Ultrasonic	Range: 0 - 11 FT	I-02	4091-252 4091- 383	FP-622-1
LSH-622-1	L18	Level Switch, Non-Mercury	Setpoint: 1 FT Above Sump Floor Above Sump Floor Rising	I-02	4091-248	CP-CHEM1
FP-622-2	N/A	Purate Fill Panel	NEMA 4X 316SS Max Allowable Dimensions: 4'H x 3'W x 1'D	I-02	4091-383	
LE/LIT-622-2	L5	Level Element and Transmitter: Ultrasonic	Range: 0 - 11 FT	I-02	4091-252 4091-383	FO-622-2
LSH-622-2	L18	Level Switch, Non-Mercury	Setpoint: 1 FT Above Sump Floor Above Sump Floor Rising	I-02	4091-248	CP-CHEM1
AE/AIT-300-1	A152	Particle Counter, Element and Transmitter	Fluid: Combined Filter Effluent Range: 0-100 NTU	I-03	4091-153	CP-FILT-MSTR

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 I-03: Chlorine Dioxide Generators

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 Low Level, Purate Storage Tank

Low Level, Sulfuric Acid Storage Tank

Low 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 High Level, Purate Storage Tank

High Level, Purate Storage Tank (created from analog input)

Low Level, Purate Storage Tank (created from analog input)

Low Low Level, Purate Storage Tank (created from analog input)

High Level, Containment Sump, Sulfuric Acid Storage Tanks

High 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 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-622-1 and FP-622-2 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-622-1

Sulfuric Acid Storage Tank, T-622-2

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 5 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 flowrates.

Generation System Low Process Flowrate Alarm

The PIC System Integrator shall configure the PLC to monitor the process flowrate associated with each of the two chlorine dioxide generation systems. 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, one per Generation System, 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**
CP-680	I-01	M-670 ~RK	RUN COMMAND, PAC SYSTEM M-670		1			
CP-680	I-01	M-670 ~FA	FAIL ALARM, PAC SYSTEM M-670	1				
CP-680	I-01	M-670 ~SK	PRODUCTION SETPOINT, PAC SYSTEM M-670				1	
CP-680	I-01	M-670 ~YS	RUN STATUS, PAC SYSTEM M-670	1				
CP-680	I-01	M-673 ~YS	ON STATUS, PAC FEEDER M-673	1				
CP-680	I-01	M-670 ~PROD	PRODUCTION RATE, PAC SYSTEM M-670			1		
			CP-680 TOTALS	3	1	1	1	
CP-CHEM1	I-02	LAH-622-1	HIGH LEVEL, SULFURIC ACID CONTAINMENT SUMP	1				
CP-CHEM1	I-02	LI-622-1	LEVELINDICATION, SULFURIC ACID STORAGE TANK			1		
CP-CHEM1	I-02	LAHH-622-1	HIGH HIGH LEVEL, SULFURIC ACID STORAGE TANK	1				
CP-CHEM1	I-02	M-620-1 ~PROD SP	PRODUCTION SETPOINT, CHLORINE DIOXIDE GENERATOR M-620-1				1	
CP-CHEM1	I-02	M-620-1 ~RK	RUN COMMAND, CHLORINE DIOXIDE GENERATOR M-620-1		1			
CP-CHEM1	I-02	M-620-1 ~YS	ON STATUS, CHLORINE DIOXIDE GENERATOR M-620-1	1				
CP-CHEM1	I-02	M-620-1 ~FA	FAIL ALARM, CHLORINE DIOXIDE GENERATOR M-620-1	1				
CP-CHEM1	I-02	M-620-1 ~PROD	PRODUCTION CHLORINE DIOXIDE GENERATOR M-620-1			1		
CP-CHEM1	I-02	LAH-622-2	HIGH LEVEL, PURATE CONTAINMENT SUMP	1				
CP-CHEM1	I-02	LI-622-2	LEVELINDICATION, PURATE STORAGE TANK			1		
CP-CHEM1	I-02	LAHH-622-2	HIGH HIGH LEVEL, PURATE STORAGE TANK	1				
			CP-CHEM1 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

	RANGE	VALUE	UNITS	COMPUTING FUNCTIONS? Y / N	CONTROL? Y / N
Indicate? Y / N	Chart:			Describe:	Action? direct / reverse
					Modes? P / I / D
Record? Y / N	Scale:				SWITCH? Y / N
					Unit Range:
Transmit/	Input:				Differential: fixed/adjustable
Convert? Y / N	Output:				Reset? automatic / manual

ANALOG CALIBRATIONS

REQUIRED			AS CALIBRATED			
Input	Indicated	Output	Increasing Input		Decreasing Input	
			Indicated	Output	Indicated	Output
CONTROL MODE SETTINGS:			P:	I:	D:	

DISCRETE CALIBRATIONS

REQUIRED			AS CALIBRATED		**Note No.**
Number	Trip Point	Reset Pt.	Trip Point	Reset Pt.	
	(note rising or falling)		(note rising or falling)		
1.					
2.					
3.					
4.					
5.					
6.					
7.					

#	**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: *A7*	Name: *Leeds & Northrup*	Number: *WDC30715.B2*
Name: *pH Element & Analyzer/Transmitter*	Model: *12429-3-2-1-7*	Name: *UOSA AWT PHASE 3*
	Serial #: *11553322*	

FUNCTIONS

	RANGE	VALUE	UNITS	COMPUTING FUNCTIONS? N	CONTROL? N
Indicate? Y Record? N	Chart:			Describe:	Action? direct / reverse Modes? P / I / D
	Scale:	*1-14*	*pH units*		SWITCH? N Unit Range:
Transmit/	Input:	*1-14*	*pH units*		Differential: fixed/adjustable
Convert? Y	Output:	*4-20*	*mA dc*		Reset? automatic / manual

ANALOG CALIBRATIONS							DISCRETE CALIBRATIONS					Note
REQUIRED			AS CALIBRATED				REQUIRED			AS CALIBRATED		
Input	Indicated	Output	Increasing Input		Decreasing Input		Number	Trip Point	Reset Pt.	Trip Point	Reset Pt.	No
			Indicated	Output	Indicated	Output		(note rising or falling)		(note rising or falling)		
1.0	*1.0*	*4.0*	*1.0*	*4.0*	*1.0*	*3.9*	1.	*N.A.*		*N.A.*		
2.3	*2.3*	*5.6*	*2.2*	*5.5*	*2.3*	*5.6*	2.					*1.*
7.5	*7.5*	*12.0*	*7.5*	*11.9*	*7.5*	*12.0*	3.					
12.7	*12.7*	*18.4*	*12.7*	*18.3*	*12.6*	*18.3*	4.					
14.0	*14.0*	*20.0*	*14.0*	*20.0*	*14.0*	*20.0*	5.					
							6.					
CONTROL MODE SETTINGS:			P: *N.A.*	I:	D:		7.					

#	NOTES:	Component Calibrated and Ready for Startup
	1. Need to recheck low pH calibration solutions.	By: *J.D. Sewell*
		Date: *Jun-6-92*
		Tag No.: AIT-12-6[pH]

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: *SFO SEWPCP*	Project Number: *SFO10145.G2*
Body	Type: *Vee-Ball*	Mfr: *Fisher Controls*
	Size: *4-inch*	Model: *1049763-2*
	Line Connection: *159 # ANSI Flanges*	Serial #: *1003220*
Operator	Type: *Pneumatic Diaphragm*	Mfr: *Fisher Controls*
	Action: *Linear - Modulated*	Model: *4060D*
	Travel: *3-inch*	Serial #: *2007330*
Positioner	Input Signal: *3-15 psi*	Mfr: *Fisher Controls*
	Action: *Direct - air to open*	Model: *20472T*
	Cam: *Equal percentage*	Serial #: *102010*
Pilot Solenoid	Action:	Mfr:
	Rating: *None*	Model:
		Serial #:
I/P Converter	Input: *4-20 mA dc*	Mfr: *Taylor*
	Output: *3-15 psi*	Model: *10-T-576-3*
	Action: *Direct*	Serial #: *1057-330*
Position Switch	Settings: *Closed / Open 5 deg, rising*	Mfr: *National Switch*
	Contacts: *Close / Close*	Model: *1049-67-3*
		Serial #: *156 &157*
Power Supply	Type: *Pneumatic*	Air Set Mfr: *Air Products*
	Potential: *40 psi*	Model: *3210D*
		Serial #: *1107063*

ADJUSTMENTS	Initial	Date	**VERIFICATION**	Initial	Date
Air Set	*JDS*	*Jun-06-92*	Valve Action	*JDS*	*Jun-03-92*
Positioner	*JDS*	*Jun-06-92*	Installation	*JDS*	*Jun-03-92*
Position Switches	*JDS*	*Jun-06-92*	Wire Connection	*JDS*	*Jun-04-92*
I/P Converter	*JDS*	*Jun-07-92*	Tube Connection	*JDS*	*Jun-04-92*
Actual Speed	*JDS*	*Jun-07-92*			

REMARKS: *Valve was initially installed backwards.*	**Valve Ready for Startup**
Observed to be correctly installed May-25-92	By: *J.D. Sewell*
	Date: *Jun-07-92*
	Tag No.: *FCV-10-2-1*

CH2M HILL **PERFORMANCE ACCEPTANCE TEST SHEET** ***Rev.06.05.92***

Project Name:	Project No.:

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.

Forms/Sheets Verified	By	Date	**Loop Accepted By Owner**
Loop Status Report			By:
Instrument Calibration Sheet			Date:
I&C Valve Calibration Sheet			
Performance Acceptance Test	By	Date	
Performed			
Witnessed			Loop No.:

CH2M HILL **PERFORMANCE ACCEPTANCE TEST SHEET** **Rev.06.05.92**

EXAMPLE

Project Name: *SFO SEWPCP Plant Expansion*	Project No.: *SFO12345.C1*

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(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*

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.*		
Performance Acceptance Test	By	Date	
Performed	*J. Blow MPSDC Co.*	*Jun-6-92*	
Witnessed	*B.deGlanville*	*Jun-6-92*	Loop No.: *30-12*

PROJECT:

Contractor:

Signed by:

AS-BUILT FIBER OPTIC CABLE INSTALLATION

Cable Identification:
Routing: From: In:
(Identify field panel, control room, etc. in building)

Through: 1
(Identify access hole, building, gallery, etc.)
Through: 2 Through: 5
Through: 3 Through: 6
Through: 4 Through: 7
To: In:
See As-Built Conduit/Innerduct Installation forms for identification of conduits/innerducts cable is routed through.

Acceptable Attenuation:
Multimode Fibers

		cable length*	
850 nm:	3.5 dB/km x	km + 1.5 dB =	dB
1300 nm:	1.0 dB/km x	km + 1.5 dB =	dB

*Contractor to provide actual length installed, within ±0.1 km.

		Measured Attenuation (dB)			
		Hub-to-Node		**Node-to-Hub**	
Fiber ID	**Use/Spare**	**850 nm**	**1,300 nm**	**850 nm**	**1,300 nm**

Single-mode Fibers

		cable length*	
1310 nm:	1.0 dB/km x	km + 1.5 dB =	dB
1550 nm:	1.0 dB/km x	km + 1.5 dB =	dB

*Contractor to provide actual length installed, within ±0.1 km.

Fiber ID	Use/Spare	Measured Attenuation (dB)			
		Hub-to-Node		Node-to-Hub	
		1,310 nm	1,550 nm	1,310 nm	1,550 nm

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. Control Panels with Three-Phase Power Supplies and Motor Starters:

1. Interlock main circuit breaker with panel door.
   a. Mount logic controls, branch circuit breakers, overload reset switches, and other control circuit devices.
   b. Mount operator controls and indications on front access door.
2. Circuit Breakers:
   a. In accordance with NEMA AB 1.
   b. 18,000-ampere RMS symmetrical rating, minimum at 480 volts, unless otherwise specified.
   c. Breakers, except Motor Branch Breakers: Molded case thermal magnetic.
   d. 65,000-ampere RMS symmetrical rating, minimum at 480 volts, unless otherwise specified in package system equipment specification sections.
   e. Tripping: Indicate with operator handle position.

3. Magnetic Motor Starters:
   a. Full voltage, NEMA ICS 2, Class A, Size O minimum.
   b. Include three-pole bimetallic or eutectic alloy thermal overload relays sized for each motor.
   c. Manual reset type with reset button mounted on panel door.
4. Motor Control: 120V ac (except intrinsically safe circuits where applicable).
   a. Power Control Transformer:
      1) Sufficient capacity to serve connected load, including 200VA for duplex outlet plus 100VA (minimum).
      2) Limit voltage variation to 15 percent during contact pickup.
      3) Fuse one side of secondary winding and ground the other.
      4) Furnish primary winding fuses in ungrounded conductors.
5. Power Monitoring Relay:
   a. Protect three-phase equipment from single phasing, phase imbalance, or phase reversal.
   b. Separate, isolated contact outputs to stop motors and activate alarm light during abnormal conditions.
   c. Transient Voltage Protection: 10,000 volts.
   d. Manufacturer and Product: Furnas; Class 47.
6. Power Distribution Blocks: Furnish to parallel feed tap on branch circuit protective devices. Do not “leap frog” power conductors.
7. Terminations for Power Conductors: Suitable for use with 75 degrees C wire at full NFPA 70, 75 degrees C ampacity.

E. 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.

F. 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.

G. 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.

H. Grounding: Internal copper grounding bus for ground connections on panels, consoles, racks, and cabinets.

I. 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.

J. 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.

K. 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. Minimum of 64 internal control relays, 16 timer/counters, and four, 16 stop drum sequencers. Furnish minimum of 256 words of nonvolatile memory.
3. 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.
4. Minimum of 25 percent excess capacity for inputs, outputs, internal coils, registers, and other necessary functions.
5. 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.
6. 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.
7. Manufacturers: Allen-Bradley ControlLogix, MicroLogix or approved equal.

L. 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.

M. 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 40 99 91
FILTER CONTROL SYSTEM

PART 1 GENERAL

1.01 SCOPE OF WORK

A. Owner has preselected and prenegotiated scope and price for the filter control system (as indicated in the attached proposal) from supplier Industrial Control System, Inc., Filter Magic for Work specified in Section 40 27 02, Process Valves and Operators, Section 43 12 01, Compressed Air Systems, and herein.

B. The prenegotiated scope includes, but is not limited to, manufacturing and furnishing equipment and materials, delivering to the jobsite, installation of equipment, testing, providing various documentation, and providing services, as specified herein. The Contractor shall coordinate with the Supplier regarding details of the Supplier's scope.

C. Contractor's responsibilities shall include, but are not limited to, procurement, unloading/ receipt at the jobsite, storage, handling, coordination, and startup.

D. Owner's preselection and prenegotiation shall in no way be construed to change, in any material way, Contractor's responsibilities under the terms and conditions of this Contract.

E. Furnish a complete Filter Control System (FCS), all related appurtenances, and services, as shown on the Drawings, and specified herein for control of a gravity-flow multi-media filter system. Services shall include but not be limited to inspection of the final installation, commissioning of the system, assistance to the Owner during field acceptance and performance tests, operator training, and warranty.

F. The specified Project Work is located at the Crosstown Water Treatment Plant owned by Fayette County Water System in Georgia. The Filter Control System Supplier shall coordinate its work throughout the Project with the Owner, Engineer, and PICS System Integrator in Section 40 99 00, Instrumentation and Control for Process Systems to minimize any impact on the plants existing production requirements.

G. The FCS shall be a complete system and shall include but not be limited to:

1. Filter System Master Control Panel (CP-FILT-MSTR).
2. Filter Control Console (CP-FIL-X, X = 1, 3, 5 and 7).
3. Filter Control Console - Slave (CP-FIL-X, X = 2, 4, 6 and 8).
4. Actuator Sensor Interface (AS-I) Bus Network.
5. Pneumatic AS-I Valve Actuators.

6. Filter Control Valves (FCV).
7. Filter Instrumentation.
8. Air Compressor System.
9. Filter System SCADA computer system (FSCADA).
10. Filter System Remote Access (FSRA).
11. Auxiliary and accessory devices that are required for a complete FCS operation and necessary to interface with existing equipment or equipment provided by other suppliers under other sections of these Specifications, shall be included whether or not they are shown on the Drawings. These devices include but are not limited to, transducers, current isolators, signal conditioners or interposing relays.

H. A single Filter Control System Supplier (FCSS) shall furnish the complete FCS including all services and equipment specified herein and in other Specification sections as listed in paragraph 1.02 Related Work. Sub-suppliers and/or manufacturers may provide components, and/or services to the FCSS, but the final product shall conform to this Specification and shall be the sole responsibility of the FCSS.

I. All materials, equipment, labor and services required to achieve a fully configured and operational FCS shall be provided by the FCSS. The FCSS shall coordinate the FCS for proper operation with related equipment and materials furnished by other suppliers under other sections of these Specifications and with related existing equipment.

J. Application software and programming required for the FCS shall be provided by the FCSS.

K. Substitution of functions or type of equipment specified shall not be acceptable, but the FCSS is encouraged to recommend changes in the design that will improve the overall filter control system subject for approval by the Owner and Engineer.

L. All equipment and installations shall be in accordance with Federal, State and Local codes, regulations and laws.

M. Where applicable, the FCSS shall coordinate with the Owner and Engineer and other suppliers under other sections of these Specifications or existing conditions on the following:

1. Interface requirements to Plant SCADA, blower systems, backwash systems, air scour systems and other related filter support systems.
2. Consistency of instrumentation.
3. Filter system control requirements.

N. The FCSS shall coordinate all required testing and training with the Owner and Engineer in a timely manner.

O. The FCSS shall submit a project schedule to the Owner and Engineer so that the Owner and Engineer can integrate the FCSS work into the overall project schedule.

P. The FCSS shall supply all necessary services to demonstrate the FCS functionality during the Operational Readiness Test (ORT) and the Functional Demonstration Test (FDT).

1.02 RELATED WORK

A. The FCSS shall furnish all materials, labor and services specified in this Specification section and related Drawings as required to ensure that a complete coordinated filter control system is supplied.

B. Divisions requiring coordination shall include, but not be limited to, the following:

1. Division 1, General Requirements.
2. Division 26, Electrical.
3. Division 40, Mechanical and Instrumentation.
4. Division 43 and 44, Equipment.

C. The FCSS shall coordinate with the Owner, the Engineer, the General Contractor, the PICS System Integrator all related equipment suppliers and subcontractors.

1.03 COORDINATION MEETINGS

A. The Engineer shall schedule and administer a minimum of two coordination meetings to be held at the Owner's facilities at the plant. The Engineer shall make arrangements for each meeting, prepare the agenda and shall provide copies of the agenda to all participants at least 1 week in advance of the scheduled meetings. The meetings shall include, as a minimum, attendance by the Owner, Engineer, General Contractor's project engineer, FCSS project engineer, the Electrical Sub-Contractor's project engineer and the Mechanical Sub-Contractor's project engineer.

1. The first coordination meeting shall be held in advance of the FCSS submittals. The purpose of the meeting is to:
   a. Summarize the FCSS and Owners understanding of the Project.
   b. Discuss control strategy requirements.
   c. Discuss any proposed substitutions, alternatives or changes to the Project.
   d. Discuss FCS project milestone dates and identify critical path activities.

e. Discuss coordination efforts required for the project that include the Filter System Supervisory Control and Data Acquisition (FSCADA) computer system and remote access (FSRA).
f. Request any additional information required for the Project from the Owner, or the Engineer.

2. The second coordination meeting shall be held after all of the FCSS submittals have been reviewed by the Engineer and returned to the FCSS. The purpose of the second meeting is to:
   a. Discuss Engineers or Owner's comments on the submittal package.
   b. Review control strategy requirements.
   c. Discuss any additional proposed substitutions, alternatives or changes to the Project.
   d. Review and refine FCS project milestones including critical path activities.
   e. Coordinate FCS equipment installation activities.
   f. Coordination and additional efforts required for the Filter System SCADA computer system (FSADA) and remote access (FSRA).
   g. Discuss and schedule additional meetings required for the project with the Owner or the Engineer.

B. All parties attending these meetings are required to pay for their own costs associated with the meetings including time, airfare, car rental, hotel expense, meal expense, etc. This includes the Owner, Engineer, General Contractor's project engineer; FCSS project engineer, the Electrical Contractor's project engineer and the Mechanical Contractor's project engineer.

1.04 SUBMITTALS

A. The submittals shall fully demonstrate that the FCS to be furnished complies with the provisions of these Specifications and provides a true and complete record of the system to be delivered. The submittal shall be securely bound with an index and sectional dividers. All submittal Drawings shall be legible and a maximum size of 11 inches by 17 inches.

B. Submittals shall include as a minimum:

1. FSCADA computer workstation hardware and software, related components, etc.
2. FSCADA graphic screens, control strategies, trends, alarms, history, reports, etc.
3. FSRA hardware and software, related components, etc.
4. CP-FILT-MSTR, related components, wiring diagrams, etc.

5. CP-FIL-X (X-1, 3, 5 and 7), related components, wiring diagrams, etc.
6. CP-FIL-X (X=2, 4, 6 and 8), related components, wiring diagrams, etc.
7. FCS control strategies and Operator Interface Terminal (OIT) graphic screens.
8. FCS network diagram.
9. Filter AS-I Network Panels, related components, etc.
10. Pneumatic AS-I Actuators.
11. Filter Control Valves.
12. Filter Instrumentation.
13. Air Compressor System.
14. Spares.
15. Operation and maintenance (O&M) manuals.
16. As-built documentation.

1.05 REFERENCE

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

1. IEC 62026-2, Low-voltage switchgear and control gear – Controller-device interfaces (CDIs) – Part 2: Actuator sensor interface (AS-I).
2. IEC 61131, Programmable Controllers.
3. AWWA C-504, Class 150B – Butterfly Valves.
4. AWWA C-540, Power Actuating Devices – Pneumatic Vane Actuators.
5. ASME B19.1 Safety Standard for Air Compressor Systems.
6. UL 508A, Industrial Control Panels and Equipment.
7. Instrument Society of America (ISA).
8. American National Standards Institute (ANSI).
9. National Electrical Manufacturers Association (NEMA).
10. National Electric Code (NEC).
11. Where reference is made to one of the above standards, the revision in effect at the time of bid shall apply.

1.06 QUALITY ASSURANCE

A. The FCS shall be a pre-packaged proven filter control system that does not require unique integration, configuration or programming services.

B. The complete FCS including all services and equipment specified herein shall be furnished by a single Supplier who is fully experienced, reputable and qualified in the design, construction and operation of pneumatic AS-I actuated filter control systems.

1. Maintains a fully equipped office / production facility with at least 15 full-time employees capable of fabricating, configuring, installing, troubleshooting and testing the system specified herein.

2. Employs personnel who have successfully completed manufacturer's training courses on the configuration and implementation of the specific equipment specified in this Project.
3. Employs qualified technicians capable of troubleshooting and repairing the specified system that can respond to the jobsite within 24 hours.
4. Has completed work of similar or greater complexity on at least five projects within the last 5 years.
5. Detailed project descriptions for a minimum of five projects including contact information for the associated consultants, general contractors and owners shall be submitted to the Engineer at least two weeks in advance of the bid date for Engineer's Approval prior to the bid date.
6. Has been in the water / wastewater industry performing the type of work specified for at least the last 10 years.

C. The FCS shall be manufactured by Filter Magic ®. No substitution is permitted.

1.07 FCSS QUALIFICATIONS

A. The FCSS shall be regularly engaged in the design and installation of pre-packaged Filter Control Systems and their associated subsystems as they apply to the municipal water or wastewater industry. The FCSS shall be an organization that complies with all of the following criteria:

1. Maintains a fully equipped office / production facility with at least 15 full-time employees capable of fabricating, configuring, installing, calibrating, troubleshooting and testing the system specified herein.
2. Employs personnel who have successfully completed manufacturer's training courses on the configuration and implementation of the specific equipment specified in this Project.
3. Employs qualified technicians capable of troubleshooting and repairing the specified controls that can respond to the job site within 24 hours.
4. Has completed work of similar or greater complexity on at least ten projects within the last 5 years.
5. Detailed project descriptions for a minimum of five projects including contact information for the associated consultants, general contractors and owners shall be submitted to the Engineer at least 2 weeks in advance of the bid date for Engineer's Approval prior to the bid date.
6. Has been in the water / wastewater industry performing the type of work specified for at least the last 10 years.

B. The FCSS shall be Industrial Control Systems, Inc. No substitution is permitted.

1.08 SYSTEM DESCRIPTION

A. Filter System Description:

1. The Filter Control System (FCS) shall be a pre-packaged filter control system.
   a. Filter System SCADA Computer System (FSCADA):
      1) The entire filter system and related components such as backwash, air scour, etc. shall be monitored and controlled through a computer workstation and related SCADA software located in the control room of the water plant as shown on the Contract Drawings. This workstation shall be responsible to monitor, control, trend, alarm, archive historical data and report on the entire filter system including related processes such as backwash, air scour, etc.
   b. Filter System Remote Access (FSRA):
      1) The entire filter system and related components such as backwash, air scour, etc. shall be monitored and controlled remotely thru portable tablets and related remote access SCADA software anywhere on the plant property through WiFi or cellular communication technology or remotely from anywhere else through cellular communication technology. The tablets shall allow operations to remotely monitor and control the entire filter system including related processes such as backwash, air scour, etc.
   c. Filter System Master Control Panel (CP-FILT-MSTR):
      1) All common elements of the filter and filter backwash systems shall be monitored, controlled and performed in CP-FILT-MSTR including the backwash, air scour and air compressor systems. The Filter Master Control Panel shall be located in the Treatment Building as shown on the Contract Drawings.
   d. Dual Filter Control Consoles: CP-FIL-X, (X=1, 3, 5 and 7):
      1) Each Filter Console shall be responsible to monitor and control the two filters directly associated with it and remotely monitor and control the additional filters in the filter building.
      2) The Filter Console is housed in a NEMA 12 Filter Magic Blue painted steel enclosure with a NEMA 4X touch screen OIT mounted on top of it. The Filter Console shall be installed in the Treatment Building as shown on the contract Drawings. The Filter Console OIT shall be fully capable of operating two filter systems thru pre-configured screens and software provided with the OIT.

e. The Filter Console shall also include a single PLC for operation of two filters with pre-configured software, AS-I Bus network controller, Ethernet switch, power supplies and other appurtenances necessary to communicate with each filter system including all related control valves and instrumentation. The FCS PLCs shall not require any PLC I/O cards in order to monitor or control the filter systems.

f. Filter Console shall communicate to the plant SCADA system through CAT 6 Ethernet cables and Ethernet switches as shown on the Contract Drawings.

g. FCS shall provide complete information for monitoring and optional remote control of the FCS to the plant SCADA system including:
   1) Filter Level.
   2) Filter LOH.
   3) Filter Effluent Flow.
   4) Filter Effluent Turbidity.
   5) Filter Control Valve Status & Control.

h. Filter Master Control Panel shall provide the FCS and plant SCADA the following information:
   1) Backwash Flow.
   2) Backwash Flow Control Valve Position & Modulating Control.
   3) Air Blower Status and Control.
   4) Air Compressor Status and Alarms.

i. Dual Filter Control Console - Slaves: CP-FIL-X, (X=2, 4, 6 and 8):
   1) Each Filter Console-Slave shall be responsible to monitor and control the two filters directly associated with it through its related Filter Console as well as remotely monitor and control the additional filters in the filter building.
   2) The Filter Console-Slave is housed in a NEMA 12 Filter Magic Blue painted steel enclosure with a NEMA 4X touch screen OIT mounted on top of it. The Filter Console-Slave shall be installed in the Treatment Building as shown on the Contract Drawings. The Filter Console-Slave OIT shall have the same capability and functionality as the related Filter Console OIT.
   3) Filter Console-Slave shall include an Ethernet switch, power supplies and other appurtenances necessary to communicate to its respective Filter Console through CAT 6 Ethernet cables and Ethernet switches as shown on the Contract Drawings.

j. FCS Dual AS-I Network Panels: Dual AS-I Network Panels shall be furnished and installed between each set of filters. Each Dual AS-I network panel shall include AS-I switches for each filter valve and AS-I input output (I/O) modules as necessary to monitor and control two filters.

k. Butterfly Valves / Pneumatic Vane Actuators:
   1) Butterfly Valves / Pneumatic Vane Actuators shall be provided as follows:
      a) Influent Open-Close FCVs.
      b) Effluent ROF Modulating FCVs.
      c) Backwash Supply Open-Close FCVs.
      d) Backwash Drain Open-Close FCVs.
      e) Air Scour Open-Close FCVs.
      f) Rewash / Filter-To-Waste Open-Close FCVs.
      g) Backwash ROF Modulating FCV.
   2) Instrumentation:
      a) Instrumentation shall be provided as follows:
         (1) Filter Level.
         (2) Filter LOH.
         (3) Filter Effluent Flow.
         (4) Filter Effluent Turbidity.
         (5) Backwash Flow.

l. Air Compressor System: A duplex rotary screw air compressor with integrally mounted high-efficiency refrigerated dryer and air receiver shall be provided to supply control air for all FCS butterfly valves and pneumatic vane actuators.

B. Application Software Development Methodology: The FCS is required to communicate with the existing Process Control System (PCS) PLC/SCADA system. It is extremely important that each PLC is programmed in a way that allows elegant data exchange between the existing PCS and other PLCs within the FCS. Coordinate data communication with the existing PCS applications programmer.

1. All current control and monitoring features of the filters in the existing PCS remain with the data now coming from the FCS.
2. Provide annotated data exchange look up tables and other information to allow the existing PCS applications programmer to implement efficient data exchange between the existing PCS and the new FCS.

1.09 BASIS OF DESIGN

A. The FCS design concept used in this project is based on an AS-I Bus Network communication system between the Filter Console and all of the FCS field devices including the Flow Control Valves and Instrumentation.

B. Alternative FCS designs will be considered by the Engineer. If accepted, the Contractor shall be responsible for all electrical, mechanical or other trade design and engineering services required to design and install the alternate FCS. The Contractor shall also be responsible for any additional costs related to the alternate FCS including engineer and design services, products, electrical and mechanical installation costs, etc.

C. If accepted, the Contractor shall not be allowed additional time to perform the work required under this Project.

1.10 DELIVERY, STORAGE AND HANDLING

A. Provide delivery, storage and handling requirements as specified below:

1. Shipping Precautions:
   a. After completion of shop assembly, factory test and approval, all equipment, cabinets, panels, consoles shall be packed in protective crates and enclosed in heavy duty polyethylene envelopes or secured sheeting to provide complete protection from damage, dust and moisture. The equipment shall then be skid-mounted for final transport. Boxed weights shall be shown on shipping tags together with instructions for unloading, transporting, storing and handling at jobsite.
   b. None of the control equipment shall be shipped to the jobsite until the storage room located at the jobsite or the final installation location at the jobsite is environmentally suitable.
2. Identification:
   a. Each component shall be tagged to identify its location, tag number and function in the system. Identification shall be prominently displayed on the outside of the package.
   b. Each piece of equipment supplied shall have a permanent stainless steel or other non-corrosive material tag firmly attached and permanently and indelibly marked with the instrument tag number, as given in the Drawings.
3. Storage: Equipment shall not be stored outside. Equipment including in-line equipment shall be stored in dry permanent shelters and adequately protected against mechanical damage. If any equipment is damaged, the Contractor at his own cost and expense shall repair such damage.

1.11 SPARE PARTS

A. Spare Parts:

1. One complete PLC system.
2. One AS-I network controller.
3. One AS-I network switch.
4. One AS-I network I/O card of each type used.

5. One AS-I actuator switch / sensor module.
6. Two pneumatic actuator single coil solenoids.
7. One pneumatic actuator dual coil center block solenoid.

B. All spare parts shall be individually packaged and labeled.

C. Spare parts shall be packed in a manner suitable for long-term storage and shall be protected against corrosion, humidity and temperature.

1.12 WARRANTY

A. The complete FCS and all related appurtenances specified herein, unless otherwise stated, shall have a comprehensive written warranty policy for 5 years from date of startup and acceptance of the system.

B. The comprehensive warranty shall include annual inspection and tuning of filter control system with staff and remedial training as needed on operation of filter control system.

C. Upon notice of a FCS failure, the FCSS shall have a qualified engineer or technician respond to the event within 24 hours to troubleshoot the problem by phone or internet, if available. In the event that the problem is not resolved by these means, then the engineer or technician will respond to the jobsite within 72 hours.

1.13 O & M MANUALS AND AS-BUILT DOCUMENTATION

A. Prior to final acceptance of the system and Owner training, operating and maintenance manuals (O&M) covering instruction and maintenance for the complete FCS shall be furnished by the FCSS.

B. The manuals shall contain all illustrations, detailed Drawings, wiring diagrams and instructions necessary for installing, operating and maintaining the equipment. The illustrated parts shall be numbered for identification. All information contained therein shall apply specifically to the equipment furnished and shall only include instructions that are applicable. All such illustrations shall be incorporated within the printing of the page to form a durable and permanent reference book.

C. As-built documentation shall include all submittal Drawings, as described in this Specification, updated to reflect the as-built system.

PART 2 PRODUCTS

2.01 GENERAL

A. Process Control System:

1. All FCS equipment and instrumentation supplied shall be of the manufacturer's latest design and established standards for the water and wastewater industry.
2. All electronic instrumentation shall be of the solid-state type and shall utilize linear transmission signals of 4 to 20 mA DC.
3. Equipment installed in a hazardous area shall meet Class, Group and Division as shown on the Drawings to comply with the National Electric Code.
4. All indicators and recorder readouts shall be linear in process units, unless otherwise noted.
5. All transmitters shall be provided with either integral indicators or remote mounted indicators in process units, accurate to 2 percent.
6. Electronic equipment shall be of the manufacturer's latest design, utilizing printed circuitry and suitably coated to prevent contamination by dust, moisture or fungus. Solid-state components shall be conservatively rated for their purpose to assure optimum long-term performance and dependability over ambient atmosphere fluctuations and 0 to 95 percent relative humidity. Field mounted equipment and system components shall be designed for installation in dusty, humid and slightly corrosive service conditions.
7. All equipment, cabinets, consoles and devices furnished hereunder shall be heavy-duty type, designed for continuous industrial service. The system shall contain products of a single manufacturer, insofar as possible, and shall consist of equipment models, which are currently in production. All equipment provided shall be modular construction and shall be capable of field expansion.
8. Field-mounted equipment and system components shall be designed for installation in dusty, humid and slightly corrosive service conditions.
9. All electronic and digital equipment shall be provided with radio frequency interference protections and shall be Filter Console approved.

B. Electrical:

1. All equipment shall be designed to operate on a 60-hertz alternating current power source at a nominal 120 volts, plus or minus 10 percent, except where specifically noted. All regulators and power supplies required for compliance with the above shall be provided between power supply and interconnected instrument loop. Where equipment requires voltage regulation, constant voltage transformers shall be supplied.

2. Materials and equipment used shall be UL approved wherever such approved equipment and materials are available.
3. All equipment shall be designed and constructed so that in the event of a power interruption, the equipment specified hereunder shall resume normal operation without manual resetting when power is restored.

2.02 LIGHTNING / SURGE PROTECTION

A. General:

1. Lightning/surge protection shall be provided to protect the electronic instrumentation, control and SCADA system from induced surges propagating along the signal and power supply lines.
2. The protection systems shall be such that the protective level shall not interfere with normal operation, but shall be lower than the instrument surge withstand level, and be maintenance free and self-restoring.
3. Instruments shall be properly grounded. Ground wires for all surge protectors shall be connected to true earth ground, and where practical, each ground wire run individually and insulated from each other.
4. Surge protectors shall be mounted within the instrument enclosure or in a separate NEMA 4 junction box coupled to the enclosure. All contact points shall be copper with nickel plating.
5. Surge protector transient response shall be less than one nanosecond.
6. Surge protector shall meet IEEE C-62-41 Standards.
7. Lightning/surge protectors shall be provided for each instrument mounted outside of a building.
8. Surge protectors shall be manufactured by Phoenix Contact, Engineer approved equal.

B. Power Supply: Lightning/surge protection for all 120 VAC equipment power supplies located in the FCS system, PLCs, panels, consoles and instrumentation shall be provided.

C. Signal Lines: Lightning/surge protectors shall be provided at each end of signal lines for field-mounted instrumentation located outside of a building. The surge protector located indoors shall be panel mounted within a panel or console.

2.03 FILTER SYSTEM SCADA COMPUTER SYSTEM (FSCADA)

A. The FCS shall be provided with a computer workstation and SCADA software (FSCADA) to monitor and control the entire filter system and filter backwash systems including the backwash and air scour systems.

B. The FSCADA shall be responsible to monitor, control, trend, alarm, archive historical data and report on the entire filter system including related processes such as backwash, air scour, etc.

C. Description:

1. FSCADA computer workstation shall be a mini-tower computer assembled with an Intel Core I7-4790 processor, 3.6 GHz, 16 GB RAM, 1 TB HDD, DVD-RW, Intel HD 4600 Graphics, Wireless N PCle Card. The operating system shall be Windows 7 Professional 64 Bit.
2. FSCADA software shall be manufactures latest version, run-time only, licensed, capable of handling unlimited inputs /outputs, include a fully integrated data historian with a minimum of 100 tags and shall be provided with 2 years of manufacturers support including updates. FSCADA software shall be capable of being upgraded to a fully redundant SCADA system in the future.
    a. A complete of HMI screens shall be provided to monitor, control, trend and alarm all aspects of the filter control system and related processes including backwash, air scour, etc.
    b. Automatic, semi-automatic and manual control of the entire filter system shall be available on the computer workstation with restricted access thru security.
    c. Semi-automatic control shall allow operations to remotely initiate a backwash on a filter from the computer workstation.
    d. Automatic control shall allow operations to place the entire filter system in a fully automatic mode of operation that utilizes a backwash queue to prioritize and automatically backwash filters.
    e. FSCADA software shall include a historical data system that allows a minimum of 100 tags to be historically saved on the server. FSCADA shall be configured to save each filters turbidity, flow and LOH for a minimum of 7 years.
    f. Historical and real-time trends for each shall be provided for each filter showing turbidity, flow, LOH and level.
3. FSCADA computer shall be provided with a driver to communicate to the FCS PLCs.
4. FSCADA shall be provided with Excel-based report software with a minimum of two licensed users.
    a. Reports shall be provided as follows:
        1) Daily 15-minute Effluent Turbidity Report shall be provided for each filter.
        2) Monthly Flow Summary Report for all filters hall be provided.
        3) Backwash Summary Report shall be provided for each backwash event.
        4) One client specified report shall be provided.
5. FCSS shall provide 2 days of operator training for the FSCADA computer workstation and related software.
6. A UPS shall be provided for the FSCADA and sized to run the filter computer workstation system for a minimum of 30 minutes in the event of normal power failure.

D. Acceptable Manufacturers:

1. FSCADA computer hardware shall be manufactured by Hewlett-Packard Model Z230 or Engineer approved equal.
2. FSCADA software shall be manufactured by GE Intellution Model iFIX Plus, version 5.8 or latest version or Engineer approved equal.
3. FSCADA driver shall be Allen Bradley SLC 5/05E PLC or Engineer approved equal.
4. FSCADA report software shall be XL Reporter latest version or Engineer approved equal.

2.04 FILTER SYSTEM REMOTE ACCESS SYSTEM (FSRA)

A. The FCS shall be provided with two tablets and remote access SCADA software (FSRA) to remotely monitor and control the entire filter system and filter backwash systems including the backwash and air scour systems.

B. Remote access to FSCADA shall be through WiFi or cellular communication technology on the plant property or remotely from anywhere else through cellular communication technology.

C. Remote access shall only be available to authorized users through security.

D. Description:

1. FSRA tablets shall utilize iOS operating system and shall include 64 GB memory, built-in WiFi and cellular communications, 2-year protection plan, Verizon cellular connectivity and hard case. The tables shall be engraved with the clients name and contact information.
2. FSRA remote access software shall be provided by the same manufacturer as the FSCADA manufacture and shall be capable of remotely monitoring and controlling the entire filter system and filter backwash systems including the backwash and air scour systems. Remote access software shall be capable of working on iOS, Android and browser-based operating systems.
    a. Remote access to FSCADA shall be through WiFi or cellular communication technology on the plant property or remotely from anywhere else through cellular communication technology.
    b. Each remote access device provided for this Project shall be licensed.
    c. FSRA shall allow expansion in the future for more remote access licenses as required by operations.
    d. Plant-wide WiFi communication technology and cellular communication technology shall be provided by others.

E. Acceptable Manufacturers:

1. FSRA tablets shall be manufactured by Apple, Model iPAD Mini 3 or Engineer approved equal.
2. FSRA remote access software shall be manufactured by GE Intellution Model iClient WebSpace or latest version or Engineer approved equal.

2.05 FILTER SYSTEM MASTER CONTROL PANEL (CP-FILT-MSTR)

A. The FCS shall be provided with a Filter Master Control Panel to monitor and control the common functions of the filter and filter backwash systems including the backwash, air scour and air compressor systems. The Filter Master Control Panel shall also control security functions for the FCS.

B. The Filter Master Control Panel program shall reside in a dedicated PLC located in the Filter Master Control Panel.

C. The Filter System Master Control Panel enclosure shall be 30-inch wide by 36-inch high by 14-inch deep and shall be NEMA 4X fiberglass with hinged and latch front access door. The enclosure shall be constructed and certified in accordance with UL508A standards.

D. The Filter Master Control Panel shall include the PLC, I/O, Ethernet switch, power supplies, field terminations and other appurtenances as necessary for a complete filter master control system.

E. A UPS shall be provided for the Filter Master Control Panel and sized to run the filter master system for a minimum of 30 minutes in the event of normal power failure. Normal power failure shall be monitored by the Filter Console PLCs and shall be displayed as an alarm on the OIT and available to plant SCADA.

F. The PLC shall be Allen-Bradley CompactLogix or Engineer approved equal and shall contain a pre-configured modular filter master control system program in accordance with IEC 61131 programming standards pre-programmed at the factory for the specific filter backwash system that it will monitor and control. The PLC shall include a power supply, processor with Ethernet communications and digital / analog input / output cards as necessary to monitor and control all required functions.

2.06 DUAL FILTER CONTROL CONSOLE

A. Each Filter Console shall be responsible to monitor and control the two filters directly associated with it and remotely monitor and control the additional filters in the filter building. The FCS shall be expandable to an unlimited number of filters.

B. The Filter Console console enclosure shall be 24-wide by 35-high (Front) by 48-high (Rear) by 18-inch deep and shall be NEMA 12 painted steel with hinged and latched top and front access doors. Filter Console shall be painted Filter Magic Blue. The enclosure shall be constructed and certified in accordance with UL508A standards.

C. A 15-inch NEMA 4X high-resolution color touch-screen OIT shall be furnished and installed in the top of the console to monitor, control and configure two filters through standard user-friendly pre-configured graphic interface screens.

D. The Filter Console enclosure shall house a FCS PLC system including AS-I network master controller, power supplies, AS-I network field interface devices, field terminations and other appurtenances as necessary to monitor and control two filter control systems.

E. A multi-port Ethernet switch shall be used for communication to all critical components of the system including the OIT, PLC and Filter Master Control Panel and to plant SCADA.

F. A UPS shall be provided and sized to run each Filter Console and its associated Filter Console-Slave including all related valve actuators for a minimum of 30 minutes in the event of normal power failure. Normal power failure shall be monitored by the Filter Console PLC and shall be displayed as an alarm on the OITs and available to plant SCADA.

G. The PLC shall be Allen-Bradley CompactLogix or Engineer approved equal and shall contain a pre-configured modular dual filter control system program in accordance with IEC 61131 programming standards pre-programmed at the factory for the specific filter systems that it will monitor and control. The PLC shall include a power supply, processor with Ethernet communications and a digital input card to monitor normal power failure.

H. Monitoring and control of the FCS system is through pre-configured graphic interface screens on the OITs. These screens include a filter system summary screen, dual filter system summary screen, individual filter monitoring and control screens, individual filter backwash setup screens and a filter system master backwash screen.

1. Filter System Summary Screen: The filter system summary screen includes a tabular spreadsheet view of all of the filters in the filter building including display of filter modes of operation, flow, level, LOH, turbidity and runtime. The screen provides access to each Filter Console dual filter summary screen throughout the filter building.

2. Filter Console Dual Filter Summary Screen: Each Filter Console dual filter summary screen includes an animated cross-sectional view of each filter including display of filter modes of operation, flow, level, LOH, turbidity, runtime and the status of all valves. The screen provides access to the individual filter monitoring and control screens by touching the cross-sectional view of each filter.
3. Filter Monitoring and Control Screens: Each filter has its own monitoring and control screen and includes an animated cross-sectional view of a filter including related piping and valves that show all the critical elements of a filter system including data for common filter backwash support systems such as backwash and air scour systems. The screen also displays filter modes of operation, flow, level, LOH, turbidity and runtime. Access to the filter backwash setup screen is through a Filter Step Pushbutton located at the top of the screen.
4. Filter Backwash Setup Screens:
    a. Access to a filter backwash setup screen is through its related filter monitoring and control screen.
    b. Each filter has its own backwash setup screen and includes a tabular-style step chart showing every program step in a backwash program. The screen has multiple set point inputs and displays for all critical functions in the backwash program including levels, flows, turbidities and timers. The screen also displays filter flow, level, LOH, turbidity and runtime.
5. Filter System Master Backwash Screen: The filter system master backwash screen shall include all of the common functions of the filter backwash system including the backwash and air scour systems.
6. Security:
    a. The FCS security access system includes three levels of security and is accessible from every screen. The three levels of security are as follows:
        1) Operator.
        2) Supervisor.
        3) Engineering / Technical.
    b. Every control variable can be assigned to any security level.
    c. Access to the system requires a username and password which are assigned and controlled by the FCS.
7. Remote Access: All monitoring and control signals for the complete FCS are available for remote access to plant SCADA through pre-built signal lists.

2.07 DUAL FILTER CONTROL CONSOLE - SLAVE (FILTER CONSOLE-SLAVE)

A. Each Filter Console-Slave shall be responsible to monitor and control the two filters directly associated with it through its respective Filter Console and remotely monitor and control the additional filters in the filter building.

B. The Filter Console-Slave console enclosure shall be 24-inch wide by 35-high (Front) by 48-inch high (Rear) by 18-inch deep and shall be NEMA 12 painted steel with hinged and latched top and front access doors. Filter Console-Slave shall be painted Filter Magic Blue. The enclosure shall be constructed and certified in accordance with UL508A standards.

C. A 15-inch NEMA 4X high-resolution color touch-screen OIT shall be furnished and installed in the top of the console to monitor, control and configure two filters through standard user-friendly pre-configured graphic interface screens.

D. The Filter Console-Slave enclosure shall house a multi-port Ethernet switch, power supplies, and other appurtenances as necessary to communicate to its respective Filter Console.

E. The associated Filter Console and its UPS shall run each Filter Console-Slave for a minimum of 30 minutes in the event of normal power failure.

F. Filter Console-Slave monitoring and control of the FCS system is through pre-configured graphic interface screens on the OITs identical to its respective Filter Console.

2.08 ACTUATOR SENSOR – INTERFACE (AS-I) BUS NETWORK

A. Each pair of filters shall have an independent AS-I network that consists of a master controller located in the Filter Console communicating with all field devices required for monitoring and control of two complete filter systems over a 2-wire 16 AWG unshielded cable configurable in linear, star, tree or ring topology. Field devices shall include all control valve actuators, ROF controllers and instrumentation required for a complete filter system. The 2-wire network shall not exceed 30 VDC to operate, shall not require more than two terminations per field device on the network and shall provide power over the same 2-wire network to operate all control valves and ROF controllers.

B. Network connection devices for each pair of filter shall be marshaled in a dual AS-I network panel located between each pair of filters in the Filter Pipe Gallery and shall allow individual control valve actuators to be disconnected from the network for service or repair without interruption of the overall network. The AS-I network panels shall be NEMA 4X polycarbonate enclosures with a hinged access door and window.

C. Each master controller shall have dual Ethernet ports available for network testing and communication to the associated Filter Console PLC.

2.09 PNEUMATIC AS-I VALVE ACTUATORS

A. Valve actuators shall be pneumatic 80 to 100 degree rotary vane AS-I controlled actuators and shall be rated for 150 psig operating pressure in strict conformance to AWWA Standard C-540-02 Power Actuating Devices – Pneumatic Vane Actuators and as specified in Section 40 27 02, Process Valves and Operators.

B. Actuators shall be pneumatic rotary vane type design with only one moving part and shall have male output shafts (square) on both sides of actuator to drive valve and accessories. Actuator shall have a vane position indicator milled into the output shaft. One side of the actuator shall be manufactured to ISO/NAMUR mounting standards for attachment of accessories including limit switches, indicators and positioners. Vane seals shall be double opposed polyurethane lip seals with stainless steel expanders. Seal backing plates shall be steel. O-ring seals on vane will not be acceptable.

C. Actuator Materials of Construction:

1. Casing: Pressure die cast A380 aluminum alloy, or A356T51 V-process sand casting with all surfaces coated with thermosetting hybrid polyester/epoxy powder coat with Ultraviolet Inhibitor.
2. Vane / Output Shaft: Steel ASTM A148 per AWWA C540-2, Grade 115-95, heat treated with electro less nickel plated finish.
3. Vane Seals: Molded polyurethane.
4. Shaft Seals: Buna N.
5. Vane Seal Expanders: Stainless spring steel.
6. Side Plates: Steel with all surfaces coated with thermosetting epoxy powder coat.
7. Bolting Hardware: Stainless steel.

D. Actuator Position, Control and AS-I Functionality:

1. Open / Close Valves:
   a. Actuators for open/close control valves shall control the valve in two positions, fully open or fully closed, using a single contact closure control scheme with a minimum of 80 psig or maximum of 150 psig applied to the actuator.
   b. Open/Close actuators shall be supplied with a direct mounted ISO/NAMUR VDI/VDE 3845 single coil (24 VDC <1 Watt) Sidewinder solenoid valve that allows independent adjustment of OPEN and CLOSE cycling speeds. Solenoid valves shall include exhaust air mufflers, OPEN/CLOSE visual indicator and an integral manual override feature to allow operation of valves in the event of power outage.

c. Open/Close actuators shall be supplied with integrally mounted Valve Communication Terminal (VCT) for control and monitoring of the actuator. The VCT shall include fully open and closed valve position solid state position sensors with LED indicators housed in a vapor-tight, explosion proof, corrosion resistant enclosure with FM and CSA ratings for NEMA 6 and IP 67 areas. Enclosure housing shall be epoxy coated anodized aluminum with a screw-on clear Lexan polycarbonate cover and Viton seal. Position sensors shall be adjustable by press, turn and release motion that does not require the use of a tool.

d. The VCT shall communicate to the AS-I network through an AS-I interface mounted in the VCT housing and shall not require more than two terminations for connection to the network.

e. VCT shall include prominent OPEN (Green color) and CLOSED (Red color) indicators.

f. Valve Communication Terminals shall be Model No. Informer / StoneL as manufactured by K-TORK or Engineer approved equal.

2. Modulating Valves:

a. Actuators for modulating control valves shall control the valve in all positions from fully open to fully closed, and from fully closed to fully open with control in any intermediate position with a minimum of 80 psig or maximum of 150 psig applied to the actuator.

b. Modulating actuators shall be supplied with a digital microprocessor-based, positioner with an integral I/P to receive a 4-20 mA signal for infinite positioning of the valve between full open or full closed positions. The positioner shall be non-bleed with negligible air consumption in a null state, have an internal 4-20 mA position transmitter and have two internal limit switches for remote indication.

c. Positioner shall have a two-line display and three pushbuttons to operate auto-stroke, manual override, speed control and failure mode functions. Failure modes shall include fail closed, fail open or fail in last position.

d. Modulating valve actuator positioners shall be Model No. S-800 as manufactured by K-TORK or Engineer approved equal.

E. Accessories such as limit switches, positioners, solenoid valves, speed controls, piping and tubing when required to complete actuator assembly, as required by the Specification, shall be mounted by the actuator manufacturer to the actuators prior to shipment to the jobsite.

F. The rated torque capability of each actuator shall be sufficient to seat, unseat, and rigidly hold, in any intermediate position, the valve disc it controls under the operating conditions specified herein. Torque safety factors shall conform to AWWA Standards and in no case be less than 1.25 times the valve manufactures published torques.

G. Actuator housings, supports, and connections to the valve shall be designed with a minimum safety factor of 5, based on the ultimate strength, or a minimum safety factor of 3, based on the yield strength of materials used.

H. Valve actuators shall be equipped with adjustable mechanical stop-limiting devices to prevent over-travel of the valve disc in the open and closed positions.

I. Pneumatic actuators shall have a maximum working pressure of 150 psig per AWWA Standard C540-2 with an overload pressure of 220 psig, NO EXCEPTIONS.

J. Actuators shall be equipped with adjustable flow-control devices controlling the operating air exhausting from the actuator. The devices shall be located at or near the actuator. The opening and closing speeds shall be nominally set for a range of 30 to 60 seconds, variable with valve sizes. Final adjustments shall be made by the purchaser to minimize line surges during normal operation.

K. Operating air pressure shall be maintained on the actuator at each end of its stroke, unless other means are provided to prevent drifting.

L. Actuator Testing:

1. Three types of actuator tests are required, a proof-of-design test, a performance test and a pressure test. The purpose of the proof-of-design test is to prove that the design, material selection, and manufacture of the actuator are suitable for the purpose intended as defined by this standard. The purpose of the performance test is to prove that each actuator is in working order prior to shipment. Actuators shall meet the requirements for each type of test.
2. Proof-of-Design Tests: One production sample of each pneumatic actuator size shall be tested. Should the actuator design be changed or modified so as to affect its strength of function, the test shall be repeated in accordance with the requirements of AWWA C504 (latest edition).
3. Performance Tests: Each actuator and valve assembly shall be cycled a minimum of three times in the field using the start and stop controls from the fully closed to the fully open position to demonstrate that the complete assembly, including controls, operates properly.
4. Pressure Tests: Each actuator shall be tested at the overload pressure. The duration of this test shall be sufficient to allow visual examination for leakage and shall be a minimum of 1 minute.

5. Actuators shall not require more than 5 psig to be cycled a complete stroke in each direction before they are connected to the valve.
6. Test Certification: Certification of tests and copies of test or certificate of conformity reports shall be provided on request if the request is made prior to the time of testing.

M. Bracket and Couplings:

1. Custom fabricated bracket to adapt the actuator to the new valves shall be heavy wall rectangular carbon steel tube and shall retain the valve stem packing or provide for use of the original draw-down packing gland as required.
2. All brackets and couplings shall have part numbers stamped into each part.
3. All brackets and couplings shall have electro statically applied fusion bonded nylon powder coated finish.
4. Couplings shall have a flat machined on the coupling for visual indication of valve disk position.
5. Couplings shall be made of bar stock carbon steel with keyway and stainless steel setscrew.
6. Brackets and couplings will be fusion bonded oven cured Nylon powder coated for maximum corrosion resistance.

N. Acceptable Manufacturers: Actuators shall be manufactured by K-TORK or Engineer approved equal and provided per schedule at end of this section.

2.10 FILTER CONTROL VALVE (FCV)

A. Filter Control Valves shall be butterfly style valves, shall have rubber seated disc, and shall be flanged body style. Valve shall provide bi-directional drip-tight shutoff at pressures of 200 psi. Shall meet the requirements of Section 40 27 02, Process Valves and Operators.

B. Body shall be ASTM A536 ductile iron and shall be suitable for use with AWWA Class 150B flanges.

C. Resilient seats shall be located on the valve disc and shall provide a 360 degree continuous, uninterrupted seating surface. The resilient seat’s mating surface shall be to a 360 degree continuous, uninterrupted stainless steel body seat ring.

D. Discs shall be ASTM A536 ductile iron and shall provide a 360 degree continuous, uninterrupted seating surface. Resilient seat shall be Buna-N and mate to a Type 316 stainless steel body seat ring. The disc / shaft connection shall be stainless steel taper pins and nuts.

E. Shafts shall be one-piece ASTM A276 type 304 or ASTMM A564 Type 630 stainless steel. Shaft seals shall be of the V-type and shall be replaceable without removal of the valve from the line or shaft from the valve.

F. All mounting hardware required to mount the valves in the pipeline including bolts, washers, nuts and gaskets shall be provided by the Contractor.

G. Acceptable Manufacturers: Valves shall be manufactured by Val-Matic Series 2000 or Engineer approved equal and provided per schedule shown below:

Valve / Actuator Schedule

Valve		Actuator			Accessories			
Name	Size	Function	Fail Position	Status		AS-I Control	Positioner	Manual Gear Override
Filters No. 1 thru 8								
Influent	12"	Open/Close	Open	New		Yes		No
Effluent ROF	12"	Modulating	Open	New		Yes	No	No
Backwash Supply	20"	Open/Close	Closed	New		Yes		No
Backwash Drain	24"	Open/Close	Closed	New		Yes		No
Air Scour	8"	Open/Close	Closed	New		Yes		No
Rewash / Filter-To-Waste	8"	Open/Close	Closed	New		Yes	No	No
Backwash								
Backwash ROF	20"	Modulating	Closed	New		No	Yes	Yes

2.11 FILTER INSTRUMENTATION

A. Ultrasonic Level Transmitters:

1. An ultrasonic level transmitter shall be provided for each filter on this Project.
2. The transmitter shall be a microprocessor-based ultrasonic level monitoring system including a transmitter and integral transducer (sensor), shall use ultrasonic technology to monitor level continuously and shall house both the sensor and the transmitter.
3. The system shall measure liquid levels in open and closed vessels. The sensor ultrasonic beam angle shall be 10 degrees at –3 dB boundary. The range shall be 0.8 to 16.4 feet and shall include automatic compensation for temperature.
4. Accuracy shall be better than plus or minus 0.25 percent of target range and resolution better than 0.125 inch. Signal damping shall be user-selectable at 5.0, 1.0 and 0.03 m/minute.

5. The measured variable shall be displayed by a three-digit LCD readout. Programming shall be through two tactile keys and the memory shall be non-volatile EEPROM with no batteries required.
6. The transmitter shall be remotely powered over a standard 2-wire loop that is also used to transmit the 4-20 mA output signal. The output signal shall be user configured for a proportional or inversely proportional signal. Maximum load on the output signal loop shall be 750 ohms at 24 VDC.
7. The transmitter operating temperature range shall be minus 40 to 60 degrees C unless mounted on metal where it shall be minus 20 to 60 degrees C.
8. The transmitter / sensor shall meet CE, CSA and FM safety standards for general-purpose locations.
9. The transmitter shall be housed in a NEMA 4X IP65 rated, molded PVC enclosure suitable for outdoor conditions. Sensor material shall be Kynar Flex.
10. The transmitter / sensor assembly dimensions shall not exceed 3.3-inch wide by 11-inch high by 4-inch deep and shall include an integral 2-inch male NPT pipe thread connection for installation.
11. Power requirements shall be 12 – 28 VDC, 0.1 A maximum. Maximum power consumption shall be 5 Watts or 200 mA at 24 VDC.
12. Options / Accessories required shall include one Universal Box Bracket (FMS-200) for mounting of transmitter.
13. The ultrasonic level monitoring system shall be in accordance with Component Spec L5 in Article Supplements of Section 40 91 00, Instrumentation and Control for Process Systems.

B. Loss of Head (LOH) Differential Pressure Transmitters:

1. A LOH differential pressure transmitter shall be provided for each filter on this Project.
2. The transmitter shall be a “Smart” technology two-wire differential pressure transmitter including three-valve manifold.
3. Process fluid shall be isolated from the sensing elements in transmitter by AISI Type 316 stainless steel diaphragms.
4. Transmitter shall have self-diagnostics and electronically adjustable span, zero and damping and shall have over-range protection to maximum line pressure.
5. Accuracy shall be 0.10 percent of span.
6. The transmitter shall be remotely powered over a standard 2-wire loop that is also used to transmit the 4-20 mA output signal and shall not be damaged by reverse polarity.
7. The transmitter operating temperature range shall be 0 to 180 degrees F.
8. Transmitter shall be factory calibrated to the required range.
9. The transmitter sensor shall meet CE, CSA and FM safety standards for general-purpose locations.

10. The transmitter shall be housed in a NEMA 4X enclosure suitable for outdoor conditions. And shall include an integrally mounted local LCD digital indicator.
11. Power requirements shall be 12 – 28 VDC, 0.1 A maximum. Maximum power consumption shall be 5 Watts or 200 mA at 24 VDC.
12. Transmitters shall be provided with brackets for wall and pipe-stand mounting and a stainless steel identification tag.
13. Transmitters shall be provided with Type 316 stainless steel three-valve manifold with test pots on the instruments side of the valves and shall be Model No. M4T as manufactured by Anderson-Greenwood or Engineer approved equal.
14. Transmitters shall be provided with filter media strainers mounted in service line to filter.
15. The LOH transmitter shall be Model 3051C as manufactured by Rosemount.

C. Rate of Flow (ROF) Differential Pressure Transmitters:

1. A differential pressure transmitter shall be provided for each filter on this Project to work in conjunctions with the filter effluent flow Venturi meter to determine filter effluent ROF.
2. The transmitter shall be a “Smart” technology two-wire differential pressure transmitter including three-valve manifold.
3. Process fluid shall be isolated from the sensing elements in transmitter by AISI Type 316 stainless steel diaphragms.
4. Transmitter shall have self-diagnostics and electronically adjustable span, zero and damping and shall have over-range protection to maximum line pressure.
5. Accuracy shall be 0.10 percent of span.
6. The transmitter shall be remotely powered over a standard 2-wire loop that is also used to transmit the 4-20 mA output signal and shall not be damaged by reverse polarity.
7. The transmitter operating temperature range shall be 0 to 180 degrees F.
8. Transmitter shall be factory calibrated to the required range.
9. The transmitter sensor shall meet CE, CSA and FM safety standards for general-purpose locations.
10. The transmitter shall be housed in a NEMA 4X enclosure suitable for outdoor conditions. And shall include an integrally mounted local LCD digital indicator.
11. Power requirements shall be 12 – 28 VDC, 0.1 A maximum. Maximum power consumption shall be 5 Watts or 200 mA at 24 VDC.

12. Transmitters shall be provided with brackets for wall and pipe-stand mounting and a stainless steel identification tag.
13. Transmitters shall be provided with Type 316 stainless steel three-valve manifold with test pots on the instruments side of the valves and shall be Model No. M4T as manufactured by Anderson-Greenwood or Engineer approved equal.
14. The ROF transmitter shall be Model 3051C as manufactured by Rosemount.

D. Rate of Flow (ROF) Venturi Flow Meters:

1. A Venturi flow meter shall be provided for each filter on this project to work in conjunctions with the filter effluent ROF transmitter to determine filter effluent ROF.
2. A Venturi flow meter shall be provided for the backwash ROF to work in conjunctions with the backwash ROF transmitter to determine backwash ROF.
3. The flow meter shall be a Venturi design utilizing pure static pressure sensing taps in the inlet and throat sections and shall produce a differential pressure, which shall be measured and transmitted by the specified differential pressure transmitter.
4. The Venturi flow meter shall have an accuracy of plus or minus 0.5 percent of actual flow above a pipe Reynolds number of 75,000 with a discharge coefficient of 0.9900 and a permanent pressure loss not exceeding 10 percent of the differential.
5. The Venturi meter shall have a cylindrical inlet section of the same inside diameter of the as the inlet piping and shall contain two high pressure taps and a single vent and drain tap. The cylindrical throat section shall contain two low-pressure taps. The length of the cylindrical throat section shall be equal to one-half of its diameter. The converging section shall be comprised of a single angle of 30 degrees. Converging sections using a radius or multiple inlet angles will not be acceptable. The recovery section shall be comprised of a single angle of 10 degrees and shall be truncated at approximately 90 percent of the downstream pipe inside diameter. The Venturi shall be provided AWWA Type 125 flanged ends unless otherwise specified.
6. The Venturi meter body shall be cast iron per ASTM A-126, Gr. B and the foundry shall be located in North America. The throat section shall be coated with NSF-61 2-part epoxy suitable for potable water contact.

7. Each Venturi meter shall be flow calibrated by an independent flow laboratory and provided with certified copies of the test results to substantiate the flow meter's accuracy, discharge coefficient and permanent pressure loss. In lieu of laboratory flow calibration, the manufacturer may provide prior independent laboratory test data substantiating the flow meter's accuracy, Reynolds number performance, installation effects, discharge coefficient and head loss. Prior test data shall cover at least 36 laboratory calibrations in sizes from 2.0 to 48.0 inches.
8. The Venturi meter manufacturer shall provide written certification that the cast iron portion of the meter is of North American origin in order to ensure that it meets applicable ASTM code requirements. In addition, in order to ensure a high level of quality control in the design and manufacturing of the above the Venturi meter, the Venturi meter manufacturer must be ISO 9001 certified and the certification must be for design, engineering and manufacturing of the Venturi meter. ISO 901 certification for just the engineering will not be acceptable.
9. All mounting hardware required to mount the valves in the pipeline including bolts, washers, nuts and gaskets shall be provided by the Contractor.
10. The manufacturer shall provide a 25-year warranty against defects in workmanship and materials.
11. The manufacturer of the Venturi meter shall have a minimum of 20 years' experience in providing differential type flow meters of the type and design specified.
12. The venturis shall be Model HVT-CI manufactured by Primary Flow Signal or BIF.

E. Turbidity Analyzers – Low Range:

1. Two turbidity analyzers shall be provided in conjunction with Owner supplied existing analyzers for a total of eight, one for each filter on this Project.
2. The turbidity analyzer shall be a microprocessor-based nephelometric analyzer / transmitters consisting of a controller unit and sample unit capable of measuring low range turbidity shall be provided to measure the effluent turbidity of each filter on this Project.
3. The turbidity analyzer shall be a continuous reading, on-line instrument using the nephelometric method of measurement. The design shall meet or exceed performance criteria as specified in USEPA Method 180.1. The analyzer shall consist of two main components: a controller unit and a sample unit, connected with a 6-foot factory supplied cable.
4. A micro-processed multifunction controller unit capable of displaying up to two devices shall display an analysis of the turbidity. The range shall be 0-100 NTU.

5. Accuracy shall be better than plus or minus 2 percent from 0 - 10 NTU, plus or minus 5 percent from 10 to 40 NTU and plus or minus 10 percent from 40 - 100 NTU, resolution better than 0.001 NTU and repeatability plus or minus 0.002 NTU.
6. The controller shall accept one or two inputs from Hach digital sensors.
7. The display shall be able to simultaneously display a single reading or dual reading or a calculated value as well as auxiliary information, which shall include analog output values, the date, time, relay status, diagnostic warnings or error messages.
8. The controller shall allow operations to control sensor and network functions with user-friendly, menu-driven software. It shall provide data logging or measurement data from up to two turbidity analyzers in user-selectable increments.
9. The controller shall have two fully isolated 4-20 mA outputs; each with 0.004 mA (12-bit) resolution and capability to drive up to 600 ohm loads. Associated values can be entered to define the endpoints at which the minimum and maximum output mA values are desired. During calibration, the selected output can hold the present value or remain active to respond to the measured value.
10. The controller shall have:
    a. Ambient operating condition range of minus 4 to plus 140 degrees F, 0 to 95 percent relative humidity, non-condensing.
    b. Three electromechanical relays; SPDT (Form C) contacts; rated 5A 115/230VAC, 5A at 30VDC resistive Function Modes including control, alarm, status, timer and indicators.
    c. Digital communications including MODBUS/RS485, MODBUS/RS232 and LonWorks with the capability to add support for other networking protocols at a later date without modification to the controller hardware.
    d. Have Integrated Infrared Data Access (IrDA) support allowing the controller and attached sensors to be fully configured and programmed and providing retrieval of data and event logs using a Laptop Computer or PDA without disrupting normal network communications.
    e. Non-volatile memory backup (EEPROM).
    f. Memory capacity to record measurement data for up to 180 days at 15 minute intervals for up to two sensors. Data shall be retrieved in CSV or XML format or by direct connection or wireless IrDA connection to a PDA, laptop computer or desktop computer.
11. The controller shall exceed U.S. and meet European standards for conducted and radiated emissions and immunity; certified CE compliant for applications as specified by EN 50081-1 for emissions and EN 50082-2 for immunity.

12. The sample unit shall offer the choice of formazin-based (20 or 1 NTU) 1-point or 2-point, verification or dry calibration methods.
13. For NPDWR and NPDES reporting the unit shall be calibrated with a Formazin standard and a calibration cylinder. The controller shall give menu instructions to perform the calibration. The manufacturer shall have available factory prepared, stable Formazin standards for this use. The unit shall also be capable of a comparative calibration against a calibrated laboratory turbidity analyzer.
14. For calibration checks, the equipment shall be provided with a solution-less calibration / verification module allowing calibration in under 40 seconds without tools. The module shall not require dismantling of the sample unit to install.
15. Calibration and calibration / verification checks shall have the ability of being done without the loss of sample flow to the unit.
16. The sample unit shall house all optical and hydraulic components in a sealed head assembly that can be removed easily for calibration / service, without disturbing sample flow.
17. The sample unit shall utilize an incandescent light source directed through the sample stream. The turbidity measurement shall consist of the light scattered at 90 degrees and sensed by a submerged photocell. The submerged photocell shall be immersed in the measuring chamber eliminating glass windows and flow cells.
18. The sample stream shall continuously flow through the sample unit and shall include an internal bubble removal system to vent entrained air from the sample stream. The bubble removal system, which is made of corrosive resistant polystyrene, shall be removable without tools for cleaning. The unit shall have integrated bubble removal circuitry to eliminate display and output fluctuations.
19. The sample unit shall accommodate the following operations criteria:
    a. Sample flow rate: 200 to 750 mL/minute.
    b. Operating temperature: 0 to 50 degrees C.
    c. Operating humidity: 5 to 95 percent non-condensing.
    d. Sample temperature: 0 to 50 degrees C.
20. The controller unit and sample unit shall include a 2-year warranty from the date of shipment.
21. The sample unit shall be constructed of corrosion resistant structural plastic and be powered by a separate power source with internal surge protection.
22. The controller unit and sample unit shall each meet UL, CSA and CE safety standards and the power requirements shall be 100 – 230 VAC, 50 / 60 Hz.
23. The sample unit shall each be housed in a NEMA 4X / IP66 corrosion-resistant polystyrene enclosure suitable for indoor installation that can be wall mounted with four screws.
24. The power supply shall have internal surge suppression for 1,000 V line-to-line and 2,000 V line-to-chassis.

25. The controller unit dimensions shall not exceed 5.67-inch wide by 5.67-inch high by 5.91-inch deep and the sample unit dimensions shall not exceed 13-inch wide by 18-inch high by 10-inch deep.
26. The sample unit shall be powered by the power supply in the controller unit through a factory supplied 6-foot cable.
27. Options / Accessories Required:
    a. Each turbidity analyzer shall be provided with a calibration / verification module.
    b. Two – Calibration Kits, StablCal stabilized Formazin, with 20 NTU standard.
    c. Two – Calibration Kits, Formazin with cylinder, pipette, 4000 NTU standard.
    d. Each turbidity analyzer shall be provided with a 25-foot extension cable, Part No. 57960-00.
    e. Each turbidity analyzer shall be provided with a strain relief power cord for 125 VAC operation.
28. The low range turbidity analyzer shall be a Model 1720E as manufactured by Hach.

2.12 AIR COMPRESSOR SYSTEM

A. An air compressor system shall be provided to provide air power for the pneumatic actuators used in the filter control system, as specified in Section 43 12 01, Compressed Air Systems.

PART 3 EXECUTION

3.01 INSTALLATION

A. The FCS including Filter Master Control Panel, all Filter Consoles, valves, actuators, instrumentation and accessory equipment shall be installed in accordance with the manufacturer’s instructions.

B. Following completion of installation and the Operational Readiness Test, one set of the marked up Drawings shall be provided to the Engineer; the other set shall be retained by the FCSS for incorporation of the markups into final as-built documentation.

C. All work shall be executed in full compliance with codes, ordinances, regulations and local rulings. Should any work be performed contrary to said codes, ordinances, regulations or local rulings, the Contractor shall bear full responsibility for such violations and assume all costs arising there from.

D. All piping to and from field instrumentation shall be provided with necessary unions, test tees, couplings, adaptors and shut-off valves.

E. The FCSS, acting through the General Contractor, shall coordinate the installation, the placing and location of system components, and their connections to the process equipment panels, cabinets and devices, subject to the Engineer's approval. The General Contractor shall schedule and coordinate his work under this section with that of the mechanical work specified and electrical work specified under applicable sections of Division 26, Electrical.

3.02 TESTS (GENERAL)

A. Unless otherwise specified in the individual Specification sections, all equipment provided shall be tested at the factory as a single fully integrated system.

B. As a minimum, the testing shall include the following:

1. Unwitnessed Factory Test (UFT).
2. Factory Acceptance Test (FAT).
3. Operational Readiness Test (ORT).
4. Functional Demonstration Test (FDT).
5. Existing Plant SCADA System Test (PSST).
6. 30-Day Site Acceptance Test (SAT).

C. Each test shall be in the cause and effect format. The person conducting the test shall initiate an input (cause) and, upon the system's or subsystem's producing the correct result (effect), the specific test requirement shall be satisfied.

D. All tests shall be conducted in accordance with prior Engineer-approved procedures, forms, and checklists. Each specific test shall be described and followed by a section for signoff by the appropriate party after its satisfactory completion. Copies of these signoff test procedures, forms and checklists will constitute the required test documentation.

E. Provide all special testing materials and equipment. Wherever possible, perform test using actual process variables, equipment and data. Where it is not practical to test with real process variables, equipment and data, provide suitable means of simulation.

F. The General Contractor shall coordinate all testing with the Engineer, FCSS, all affected Subcontractors and the Owner.

G. The Engineer reserves the right to test or retest all specified functions whether or not explicitly stated in the prior approved Test Procedures.

H. The Engineer's decision shall be final regarding the acceptability and completeness of all testing.

I. No equipment shall be shipped to the jobsite until the Engineer has received all test results and approved the system as ready for shipment.

J. The FCSS shall furnish the services of servicemen, all special calibration and test equipment and labor to perform all required tests for equipment provided by FCSS.

K. Correction of Deficiencies:

1. All deficiencies in workmanship and/or items not meeting specified testing requirements shall be corrected to meet Specification requirements at no additional cost to the Owner.
2. Testing, as specified herein, shall be repeated after correction of deficiencies is made until the specified requirements are met. This work shall be performed at no additional cost to the Owner.

3.03 UNWITNESSED FACTORY TEST (UFT)

A. The entire system, except primary elements, final control elements and field mounted transmitters, shall be interconnected and tested to ensure the system operates as specified. All analog and discrete input / output points not interconnected at this time shall be simulated to ensure proper operation of all alarms, monitoring devices / functions and control devices / functions.

B. All panels and assemblies shall be inspected and tested by the FCSS to verify that they are in conformance with related submittals, Specifications and Drawings.

C. The UFT shall be performed by the FCSS at their facility within the continental United States of America.

D. The UFT results shall be submitted to the Engineer for approval prior to the start of the FAT.

3.04 FACTORY ACCEPTANCE TEST (FAT)

A. The FAT shall be performed by the FCSS at their facility within the continental United States of America.

B. All system tests specified for the UFT shall be repeated.

C. The FAT will be a joint test by the FCSS, General Contractor, Engineer, Owner and other related subcontractors.

D. After completing the UFT, the FCSS shall notify the Owner and General Contractor in writing that the system is ready for the FAT. The Engineer and Owner shall schedule a test date within 10 days of receipt of the “Ready to FAT” letter.

E. The purpose of the test shall be to verify the functionality, performance and stability of the hardware and software. The system must operate continuously for 72 hours without failure before the test shall be judged successful. Successful completion of this test, as determined by the Engineer, shall be the basis for approval of the system to be shipped to the jobsite.

F. The various tests performed during the FAT shall be designed to demonstrate that all hardware and software fulfill all the requirements of the Specifications and Contract Drawings. The test conditions shall resemble, as closely as possible, the actual installed conditions. Any additional hardware or software that may be required to successfully verify system operation shall be supplied at no additional cost to the Owner.

G. All control panels shall be included in these tests, except for multiple filter consoles from each filter system. The rest of the filter consoles will be shipped to the jobsite once the Engineer has inspected and approved them for shipment from the FCSS facility.

H. All deficiencies identified during these tests shall be corrected and retested prior to completing the FAT as determined by the Engineer/Owner.

I. All test data and procedures followed during the testing shall be logged and certified copies of the logs shall be provided to the Engineer/Owner.

J. All parties attending these tests are required to pay for their own costs associated with the tests including time, airfare, car rental, hotel expense, meal expense, etc. This includes the Owner, Engineer, General Contractor’s project engineer and support personnel.

3.05 OPERATIONAL READINESS TEST (ORT)

A. Prior to startup and the FDT, the entire system shall be certified, inspected, tested and documented that it is ready for operation.

B. The ORT will be a joint test by the FCSS, General Contractor, Engineer and other related subcontractors and shall be conducted at the Owners facility.

C. Loop/Component Inspections and Tests: The entire system shall be checked for proper installation, calibrated and adjusted on a loop-by-loop and component-by-component basis by the FCSS to ensure that it is in conformance with related submittals and these Specifications.

D. The General Contractor shall require the FCSS to maintain Loop Status Reports and Component Calibration Sheets at the jobsite and make them available to the Engineer/Owner at any time.

E. The inspections and tests do not require witnessing. However, the Engineer shall review and initial all Loop Status Sheets and Component Calibration Sheets and spot-check their entries periodically and upon completion of the ORT. Any deficiencies found shall be corrected.

3.06 FUNCTIONAL DEMONSTRATION TEST (FDT)

A. Prior to startup and the SAT, the entire installed instrument and control system shall be certified that it is ready for operation.

B. The FDT will be a joint test by the FCSS, General Contractor, Engineer, Owner and other related subcontractors and shall be conducted at the Owners facility.

C. Once the facility has been started up and is operating, a witnessed FDT shall be performed on the complete system to demonstrate that it is operating and in compliance with these Specifications. Each specified function shall be demonstrated on a paragraph-by-paragraph, loop-by-loop and site-by-site basis.

D. Loop-specific and non-loop-specific tests shall be the same as specified under FDT except that the entire installed system shall be tested and all functionality demonstrated.

E. The system shall operate for 72 continuous hours without failure before the test shall be considered successful.

F. Demonstrate communication failure and recovery.

G. Demonstrate total power failure and recovery including the UPSs.

H. Demonstrate a catastrophic failure and recovery of an OIT, PLC and AS-I Network Controller.

3.07 EXISTING PLANT SCADA SYSTEM TEST (PSST)

A. Prior to startup and the SAT, the existing filter monitoring and control system shall be removed from the plant SCADA system and replaced with a new filter monitoring and control system without interrupting plant operations.

B. The new filter monitoring and control system shall:

1. Replicate all of the functions and OIT screens in the Filter Consoles.
2. It shall allow remote initiation of backwashes and remote manual control of filters if authorized by management.
3. It shall include operational trends for the filter system and each filter including level, loss-of-head, rate-of-flow and time.
4. It shall include an alarm system for all critical functions of the FCS.
5. It shall include filter system summary reports.

C. The PSST will be a joint test by the FCSS, General Contractor, Engineer, Owner and other related subcontractors and shall be conducted at the Owners facility.

D. Once the facility has been started up and is operating, a witnessed PSST shall be performed on the new filter monitoring and control system to demonstrate that it is operating and in compliance with these Specifications.

3.08 30-DAY ACCEPTANCE TEST (SAT)

A. After completion of the ORT, FDT and PSST test, the entire system shall be operated for a period of 30 consecutive days, under conditions of full plant process operation, without a single non-field repairable malfunction.

B. The SAT will be a joint test by the FCSS, General Contractor, Engineer, Owner and other related subcontractors and shall be conducted at the Owners facility.

C. During the test, plant operating, Engineering and FCSS personnel shall be present as required.

D. While the test is proceeding, the Owner shall have full use of the system. Only certified plant operating personnel shall be allowed to operate equipment associated with the actual water production process.

E. Any malfunction during the tests shall be analyzed and corrected by the responsible party immediately. The Engineer/Owner will determine whether any such malfunctions are sufficiently serious to warrant a repeat of this test.

F. During the 30 consecutive day test period, any malfunction which cannot be corrected within 24 hours of occurrence by the responsible party, or more than two similar failures of any duration, will be considered a non-field-repairable malfunction.

G. Upon completion of a non-field-repairable malfunction, the test shall be repeated as specified herein.

H. Down times due to power outages or other factors outside the normal protection devices or back-up power supplies provided shall not be considered a non-field-repairable malfunction.

I. Down times due to plant process equipment failures or other factors beyond the control of FCSS shall not be considered a non-field-repairable malfunction.

J. Upon successful completion of the SAT and subsequent review and approval by the Engineer of the complete system final documentation, the system shall be considered substantially complete, and a one-year warranty period shall commence.

3.09 TRAINING

A. General:

1. The cost of training programs for the Owner's personnel shall be included in the Contract price. Where practical, the training and instruction shall be directly related to the system being applied.
2. Training shall be conducted at the manufacturer's training facility, FCSS facility, Engineers facility or the Owner's facility.
3. All Technicians, Operators, Engineers and Managers of the Owner shall require training on the system. The training courses shall address operation, maintenance and troubleshooting of the system provided. The courses shall be designed specifically for the type of personnel attending, such as Operators, Engineers, etc.
4. All training schedules shall be coordinated with and at the convenience of the Owner. Shift training shall be used where required by the Owner's operations schedule.
5. Provide training manuals to supplement the training courses. The manuals shall include specific details of equipment supplied and operations specific to the Project.
6. The trainer shall make use of teaching aids, manuals, slide/video presentations, etc. After the training services, all training materials shall be delivered to the Owner.

B. Field Training (provided by FCSS):

1. Provide 2 day's training course for two of Owner's personnel in the operation, configuration, programming, installation and maintenance of the FCS.
2. This training shall be conducted no more than 1 month before the FDT.
3. Training shall consist of hands-on instruction utilizing the Owner's system.

4. The following training shall be provided, as a minimum:
    a. Training in standard hardware maintenance.
    b. Specific training for the actual FCS configuration to provide a detailed understanding of how the equipment and components are arranged connected and set up for this Contract.
    c. Test, adjustment, calibration and configuration procedures.
    d. Troubleshooting and diagnostics.
    e. Periodic maintenance.

3.10 SUPPLEMENT

A. The supplement listed below, which follows “END OF SECTION,” is part of this Specification.

1. Supplement 1, Eshelman Combined Solution Incentives, January 7, 2015 - AWI Filter & ICS Filter Magic.

END OF SECTION

P.O. BOX 71595
MARIETTA, GA 30007-1595
PH 770/933-0013
FAX 770/ 933-1823 or 933-9528

THE ESHELMAN COMPANY

Fayette County
Mr. Steven (Lee) Pope
Water System Director
245 McDonough Road
Fayetteville Georgia 30214

Re: Crosstown WTP
Eshelman Combined Solution Incentives
AWI Filter & ICS Filter Magic

Dear Mr. Pope:

The Eshelman Company is pleased to present our **Combined Solution Incentives** for your consideration at the Crosstown WTP in Peachtree City, GA.

Fayette County is rebuilding eight (8) 14'W x 28'L filters at this facility. Included in this rebuild are new underdrains, media, valves, actuators, instrumentation, AS-I bus network, and the complete filter control system. Backwash air scour capability is being added to the filters. The existing filter control system utilizes hydraulic-powered actuators and we have proposed upgrading to pneumatic vane actuators (K-Tork).

Earlier in the design phase of this project, The Eshelman Company provided the following pricing (exclusive of taxes) for our system components:

AWI Filter Base Offering: **$475,000**

- Phoenix Underdrains in 304 ss, outfitted with air scour, including air supply manifold, freight, and start-up services
- One (1) Year Standard Warranty

ICS - Filter Magic Base Offering: **$1,125,000**

- ICS - Filter Magic w/ Pneumatic Control & Four (4) Dual Control Consoles
- AS-I Bus Network
- K-Tork Pneumatic Actuators, Val-Matic Valves
- Kaeser Duplex Compressor
- Spares, FAT Test, and Start-up
- Three (3) Year Extended Warranty

Sub-Total – AWI & ICS Base Offering: ***$1,600,000***

Eshelman Combined Solution Incentives:

The Eshelman Company has worked with our suppliers to create specific incentives for this project based on AWI and ICS being pre-selected for implementation on the Crosstown WTP Project. The incentives are as follows:

- AWI Filter – Five (5) Year Extended Warranty
- ICS – Five (5) Year Extended Warranty
- ICS – New Filter Magic SCADA Computer System with GE Intellution iFIX Plus SCADA Software, GE Intellution iHistorian Software, and uninterruptible power supply. Complete Integration of Filter Magic System into upgraded FM SCADA Control System: Includes full set of HMI screens, trends, historical data, alarms, and reports for filters. SCADA integration will allow Crosstown WTP staff to fully operate and control Filter Magic filter control system from control room. New FM SCADA System will be able to accommodate collection of historical data for trending and reports (7-10 years @ 15 minute logging). The new Filter Magic SCADA Computer System and software will have capability to be expanded and integrated to include a complete plant SCADA system in the future.
- ICS – Operator Training in EACH year of Extended Warranty
- AWI & ICS - Factory Tour(s)

Additionally, The Eshelman Company is offering Fayette County this entire package for a discounted total net Base Offering Price of $1,495,000. This price is contingent on the County pre-selecting AWI and ICS for the proposed components, with their proposals being integral to the bid documents with a line-item price for the combination in the bid form (including any optional equipment adders selected by the County to be provided by these suppliers). Individual purchase orders would be issued by the contractor to both AWI and ICS after award of contract, in accordance with the proposals in the bid documents. Please refer to the attached proposals for additional pricing information, including that requested for optional equipment adders.

Media Pricing:

Last August, The Eshelman Company provided CH2M Hill a budget price of $115,000 plus freight for the sand+anthracite media for the Eight (8) 14' x 28' filters with 12" sand and 24" anthracite. AWI Filter and The Eshelman Company offer the following firm pricing and options for the media:

OPTION 1:	12" sand + 24" anthracite, including freight	**$145,752**

- OR –

OPTION 2:	12" sand + 24" Puracite, including freight	**$209,043**

Option 2 contains Puracite media, which when combined with sand of a specific media gradation and characteristic, is able to backwash efficiently and appropriately at reduced hydraulic backwash rates. The media selected for Crosstown is specifically suited to backwash at 15 gpm/sq.ft, which could allow the County to forego the costs of upgrading the existing backwash pumps to achieve the desired bed expansion (ie. 20-25 gpm/sq.ft. backwash rate). Puracite media is fully NSF approved and installed in filters throughout the U.S. and North America, including projects engineered and managed by CH2M Hill. Note that pricing for Puracite is based on it being provided in conjunction with AWI Phoenix Underdrains.

Fayette County is the benefactor of our suppliers' desire to create a showcase installation for this technology package here in the southeast. The technology being offered is the premier in the industry for performance, quality, and reliability, and the value being offered to Fayette County is unmatched. We hope our offer is well received and look forward to the possibility of creating a showcase installation for all of us.

Kind regards,

Chris Keever

CC: Steve Osburne

PROPRIETARY AND CONFIDENTIAL INFORMATION

The attached document contains proprietary and confidential information and is submitted under a confidential relationship for the sole purpose of responding to a request to solve various process and operational problems.

By accepting this document, the recipient agrees:

(a) it will not disclose to third parties or use any drawings, specifications, designs, processes or information supplied by AWI in any manner detrimental to the interests of AWI,

(b) any special features peculiar to this design and information gained as a result of this document shall be treated as confidential and shall be the property of AWI and will not be incorporated in whole or in part in other projects unless recipient obtains written permission from AWI to do so,

(c) not to copy in whole or in part nor reveal its contents in any manner or for any other purpose except for the purpose stated herein,

(d) the foregoing applies, without limitation, to all documents prepared by AWI in connection with this submission and the recipient acknowledges this document involves confidential, proprietary rights of AWI and all design, manufacturing, reproduction, use and sale rights regarding same as expressly reserved.

INTRODUCTION

AWI FILTER SYSTEMS

AWI has been upgrading variety granular media filters, including open top gravity filters for more than 20 years. AWI uses a combination of design principles developed from decades of actual field experience along with the latest innovations in granular media filtration technology. The features offered in this proposal have all been proven in actual production installations.

AWI PHOENIX UNDERDRAIN SYSTEM

The most critical component of any granular media filter is the underdrain system. It collects filtered water during filtration, and cleans the filter media by controlling air scour and the backwash water distribution, all of which has a profound affect on the overall filtration efficiency and filter media life. The AWI Phoenix underdrain system is the most advanced underdrain system on the market today. It offers significant advantages over older designs such as header/lateral systems, filter plates with nozzles, tile block, plastic block or gravel supported systems. Some of the advantages are:

1. Stainless steel construction makes the system much more durable than the plastic nozzles plastic blocks. The bolt together system can usually be installed in half the time of other systems.

2. The stainless steel orifice shields eliminate the need for gravel to support the filter media. Consequently there is no loss of filter media from a disturbed gravel bed.

3. The air and water orifice sizes in the laterals are computer selected to insure uniform distribution along the entire length of each flute. This is not practical with other underdrain systems.

4. The problem of poor distribution of air scour air due to the formation of water waves in the laterals and header common to other systems is eliminated by AWI's provision of a physical barrier to separate the air and water channels.

5. The underdrain is designed specifically to take advantage of simultaneous air scour/low rate hydraulic backwash. In many applications where this backwash method is applied, backwash water volume reductions of up to 50% have been realized.

Reference installations are available upon request.

EQUIPMENT DESCRIPTION

AWI proposes to furnish as noted underdrain systems suitable for installation in the facility consisting of eight (8) filter basins 28’ x 14’ at the Crosstown WTP in Fayette County, Georgia. The following items are included:

- **Phoenix Underdrains**
  - Stainless Steel Laterals with Integral Seal Plate
  - Stainless Steel Hold Down System
  - Stainless Steel Air Scour Header
  - Gaskets, Sealant, and Installation Hardware
  - Filter Media
  - Installation, Operation and Maintenance Manuals
  - Service as Noted
  - Freight Terms: FOB Jobsite

ITEM 1 – EIGHT (8) PHOENIX UNDERDRAIN SYSTEMS FOR INSTALLATION IN THE 28' – 0" x 14' – 0" FILTER BASIN

AWI will supply eight (8) complete Phoenix Underdrain Systems fabricated from stainless steel, and custom designed specifically to be installed in the eight (8) 28' – 0" x 14' – 0" filter basin. The scope of supply for the each filter basin will include the following:

A. A minimum of 28 two-compartment air/water flute laterals of 304L stainless steel construction, with variably sized water orifices, air scour slots, air release vents, and orifice shields. The flutes shall be designed to prevent two phase wave action generation during air scour, and will compensate for velocity and momentum changes during backwash. Each lateral will have an air nipple for connection to the air manifold located in the gullet. The laterals will feed into a concrete gullet cast into each filter basin (concrete floor and gullet not by AWI).

B. The cover plate will include a series of variably sized orifices to collect filtered water and evenly distribute backwash water to the laterals.

C. 120 stainless steel hold down clamps.

D. An 8" air scour header fabricated from schedule10 stainless steel material with individual j-tube connections to the air section of each lateral. The manifold will have an 8" flange to connect to existing plant piping. The header will come with 4 supports. All material to be 304L Stainless steel.

E. Includes all required gaskets, anchor bolts, adhesive, hoses, hose clamps, leveling shims, and sealant.

The underdrain system will be shop assembled for rapid bolted installation to the concrete floor in the field.

All components will be packed in crates.

ITEM 2 – FILTER GRADE SILICA SAND

AWI proposes to furnish filter grade silica sand, for eight (8) granular media filters. The following items are included:

FILTER GRADE SILICA SAND

- Quantity ..... 4,120 cubic feet

MEDIA SPECIFICATION TBD

ITEM 3 – FILTER GRADE COAL

AWI proposes to furnish filter grade coal for eight (8) granular media filters. The following items are included:

FILTER GRADE COAL (ANTHRACITE)

- Quantity ..... 6,590 cubic feet
- Specific Gravity 1.7

MEDIA SPECIFICATION TBD

OR

FILTER GRADE COAL (PURACITE)

- Quantity ..... 6,590 cubic feet
- Specific Gravity 1.4

MEDIA SPECIFICATION TBD

ITEM 3 – INSTALLATION SUPERVISION

AWI will supply a service engineer to provide supervision for the installation of the first two filters and inspection of all eight filters. Fifteen (20) days and five (8) trips are included.

FURNISHED BY OTHERS

Unless specifically mentioned in this proposal and purchase for inclusion with the proposed equipment, AWI does not include:

- Unloading
- Concrete foundations
- Special engineering
- Valves
- Field wiring and conduits
- Interconnecting piping
- Instrument air piping
- Field Painting
- Field erection (unless specified)
- Grouting
- Trough

PRICE AND DELIVERY

ITEM 1 – Supply of eight (8) AWI Phoenix Underdrain Systems.

Purchase Price (Freight FOB Jobsite)..... LATER

ITEM 2 – Filter Grade Silica Sand.

Purchase Price (Freight FOB Jobsite)..... LATER

ITEM 3 – Filter Grade Coal.

Puracite Purchase Price (Freight FOB Jobsite)..... LATER

Anthracite Purchase Price (Freight FOB Jobsite)..... LATER

ITEM 4 – Installation Service

Purchase Price..... Included

STANDARD PAYMENT TERMS

The total amount of the order shall be payable as follows:

- 30% upon submittal of approval drawings
- 70% upon shipment of equipment

Credit is subject to acceptance by our Credit Department. All invoices are due and payable within thirty (30) days of the date rendered.

SHIPMENT SCHEDULE

Standard shipment schedule for first two filters is 22 weeks.

Engineering/Drawing Preparation	4 weeks
Drawing Approval	2 weeks
Fabrication and Shipment	12 – 16 weeks

Modification of shipment schedule can be discussed at the time of purchase.

FIRM PRICE BID

The prices submitted are based upon receipt of an order on or before February 12, 2015 and customer acceptance of shipment when we are scheduled to ship. If the above indicated order date is exceeded, prices and shipping dates are subject to review and adjustment.

Should shipment dates be exceeded because of customer action, escalation of the sell prices at the rate of 1.5% per month for each additional or partial month of delay will be applied. This escalation will be applied only if shipment is delayed by the customer. Unauthorized retention of payment for any reason by purchaser shall result in a service charge of 2% per month.

DRAWINGS & INFORMATION

General arrangement drawings will be submitted for approval as noted after receipt of a written purchase order. Four (4) sets of erection drawings and operating and maintenance instructions will be forwarded at the time of shipment of the equipment.

CUSTOMER SERVICE

Customer service is provided as noted in this proposal. AWI will provide upon request additional services of experienced personnel for construction/installation consultation, mechanical inspection, operator training, and equipment start-up.

This service will be provided at the rate in effect at the time that service is performed, plus travel and accommodation expenses. The service time billing will include travel time from AWI premises to the job site and return.

Service rates in effect as of January 1, 2015 are as follows:

Monday through Friday:	$850.00 per 8 hour man day
Overtime:	1-1/2 times above rate.
Saturday:	1-1/2 times above rate.
Sunday:	2 times above rate.

The above rates are subject to adjustment without notice to conform to the rates in effect at the time the work is performed.

TAXES

State sales or use taxes are not included in our quoted price. Any such taxes incurred by AWI, or required to be passed on to AWI by any of its subcontractors, will be added to the previously quoted price to arrive at the total sales price. AWI will advise Purchaser of the amount of such taxes as soon as they are determined at which time Purchaser shall immediately provide AWI with a change order to reflect the taxes being added to arrive at the total sales price.

TERMS AND CONDITIONS

WARRANTY AND CONDITIONS

AWI Standard Warranty is attached and made a part of this proposal. Warranty and service policies are limited to equipment of AWI design and manufacture. Equipment, which is neither of AWI manufacture, nor integral to AWI equipment will be subject to warranty and service policies of the respective manufacturer.

PROCESS PERFORMANCE CONDITIONS

The process performance of the equipment offered in this proposal is dependent upon many factors, including the influent or feed quality and quantity, additives required, time, temperature, rates of change, sizing criteria used, operating conditions, etc. Therefore, unless a written process performance warranty has been included, AWI cannot assume any liability or responsibility for performance results that the user of the equipment is expecting or has predicted.

LIMITATION OF LIABILITY

AWI shall not be liable for incidental or consequential losses or damages for any reason in connection with this order.

PROPOSAL DRAWINGS

Drawings bound with this proposal are general in nature and are for purposes of illustration only. The written proposal description defines our offering and takes precedence over these drawings. Weights and volumes given are approximate only and are given to aid in estimating costs for handling and erection.

SPECIFICATIONS

AWI is furnishing its standard equipment in accordance with engineering and manufacturing standards as outlined in the proposal and as will be covered by final approved drawings. The equipment may not be in strict compliance with the Engineer's/Purchaser's plans, specifications or addenda, as there may be minor deviations. The equipment will, however, meet the general intent of the mechanical specifications of these documents.

FORCE MAJEURE

The Seller shall not be liable for loss, damage, detention, or delay resulting from causes beyond its reasonable control, or caused by fire, strike, civil or military authority, restrictions of the United States government, or any department, branch or representative thereof, insurrection, riot, embargoes, car shortages, wrecks, or delays in transportation, or inability to obtain necessary labor, materials, or manufacturing facilities due to such causes.

LOCAL CODES, CRITERIA OR ORDINANCES

The equipment offered in this proposal is designed and furnished in accordance with nationally accepted practices. Local or state practices, codes, criteria or ordinances which differ from those in general acceptance will not be included in the design unless the specification sections relating to the equipment specifically call for the local requirements, and copies of all such codes, criteria and ordinances are included in the bid specifications supplied to AWI.

OCCUPATIONAL SAFETY & HEALTH ACT OF 1970 (OSHA)

AWI warrants that in addition to meeting all OSHA specifications as recited, its equipment also meets those regulations of general application such as the standards relating to handrails, belt guards, electrical wiring and the like; and AWI will correct any deviation in accordance with the AWI Warranty under which the equipment is sold.

However, we must point out that the purpose of this Federal legislation is to insure that employers provide a safe working environment for their employees. Thus, the burden of compliance is on the Purchaser-Employer rather than on the supplier of equipment because the conditions under which work will be performed can vary.

While AWI makes every effort to comply with regulations of specific application to equipment of its manufacture, we do not always know every particular use to which the equipment will be put, the environment in which it may be used, nor do we know whether the equipment will always be properly maintained and/or operated within its design capacities. For these reasons, AWI cannot give the Purchaser-Employer blanket assurance that equipment you purchase from AWI will, in use, always comply in all respects with OSHA.

WARS AND EMBARGOES

If foreign or United States wars or embargoes, or interruption of essential transportation services cause serious shortages, unavailability or significant increases in the price of commodities, materials or components used by Seller in the manufacture or erection of equipment, the delivery period shall be extended and the price increased to compensate for the changes in these conditions.

COMPLETION

Due to this equipment being custom designed to meet specifications for the benefit of the Purchaser and not resalable without modification, Seller shall be relieved of any clause covering time is of the essence or default which might be invoked on account of late delivery. Seller shall not be considered in default, nor shall the order be subject to cancellation without payment to the Seller of appropriate cancellation costs. This does not deny Purchaser the right to cancel in cases of Seller's gross negligence or willful breach.

PROPOSAL WITHDRAWAL

AWI reserves the right to withdraw this proposal at any time prior to the written acceptance of your written purchase order.

Warranty

Anthratech U.S. Inc.

Standard Warranty

For the benefit of the original user, Anthratech U.S. (dba AWI) warrants all new equipment manufactured by or for it to be free from defects in material and workmanship; and will replace or repair, F.O.B. Sandy, Utah or other location designated by it, any part or parts returned to it which examination shall show to have failed under normal use and service by the original user within one year following initial shipment by AWI. Such repair or replacement shall be free of charge except for those parts such as filter media and the like that are consumable and normally replaced during maintenance. Such consumables shall be subject to pro-rata charge based upon AWI's estimate of the percentage of normal service life realized from the part. AWI's obligation under this warranty is conditioned upon its receiving prompt notice of claimed defects which shall in no event be later than thirty (30) days following expiration of the one year warranty period and is limited to repair or replacement as aforesaid.

THIS WARRANTY, INCLUDING THE STATED REMEDIES, IS EXPRESSLY MADE BY AWI U.S. AND ACCEPTED BY PURCHASER IN LIEU OF ALL OTHER WARRANTIES, INCLUDING WARRANTIES OF MERCHANTABILITY AND FITNESS FOR PARTICULAR PURPOSE WHETHER WRITTEN, ORAL, EXPRESS, IMPLIED, OR STATUTORY. AWI U.S. NEITHER ASSUMES NOR AUTHORIZES ANY OTHER PERSON TO ASSUME FOR IT ANY OTHER LIABILITIES WITH RESPECT TO ITS EQUIPMENT. AWI U.S. SHALL NOT BE LIABLE FOR NORMAL WEAR AND TEAR, NOR FOR ANY INCIDENTAL OR CONSEQUENTIAL DAMAGE DUE TO INOPERABILITY OF ITS EQUIPMENT FOR ANY REASON NOR ON ANY CLAIM THAT ITS EQUIPMENT WAS NEGLIGENTLY DESIGNED OR MANUFACTURED.

This warranty shall not apply to equipment or parts thereof which have been altered or repaired by parties other than AWI and its authorized agents. Neither does this warranty apply if the equipment or parts have been damaged by improper installation, application**,** erosion or corrosion of any sort, or subjected to misuse, abuse, neglect or accident.

AWI makes no warranty with respect to parts, accessories, or components manufactured by others. The warranty applicable to such items is that offered by their respective manufacturers.

AUS 3/9

Industrial Control Systems, Inc.
20 West Williamsburg Road • Sandston, VA 23150
(804) 737-1700 •FAX (804) 737-7133
www.ics-scada.com

Fayette County Water System
245 McDonough Road
Fayetteville, GA 30214

January 6, 2015

Attention: Lee Pope

Re: Fayette County Water System
Crosstown Water Treatment Plant
Filter Magic Pneumatic Control System
Proposal

Dear Lee:

We are pleased to offer our proposal for a "Filter Magic (FM) Pneumatic Control System" for the above-referenced project, based on our discussions, your direction and tour of the existing water plant. The control system includes four (4) dual filter control systems for a total of 13.5 MGD and eight (8) filters.

Our Proposal Includes:

Lump Sum $_____

- Submittals & Drawings
- Engineering
- Meetings
- Programming
- Filter Magic Filter Control System
- *Filter Magic SCADA Computer System (Described Below)*
- Panels
  - 4 - Dual Filter Magic Control Consoles – NEMA 12 with UPSs
  - 1 - Filter Magic Master Control Panel - NEMA 12 with UPS
  - 4 - Dual Filter Magic AS-I Panel – NEMA 4X
- AS-I Network System including Cable & Termination
- Instrumentation
  - 8 - Filter Ultrasonic Level Transmitters
  - 2 - Filter Effluent Turbidity Transmitters
  - 8 - Filter LOH Transmitters
  - 8 - Filter Effluent ROF Transmitters
  - 8 - Filter Effluent ROF 12" Venturis
- Spare Parts Allowance - $7,600.00
- FAT Test
- Installation Supervision
- Calibration
- Start-up
- Training (1 Week)
- *Five (5) Year Comprehensive Filter Magic Warranty including annual inspection, tuning and training of the filter control system.*

- Butterfly Valves, Pneumatic AS-I Actuators & Air Compressor

  - 8 – 12” Influent Valves
    Val-Matic Class 150B AWWA Butterfly Valves
    K-Tork Pneumatic Actuators
    FM AS-Interface
    Open-Close Operation

  - 8 – 12” Effluent ROF Valves
    Val-Matic Class 150B AWWA Butterfly Valves
    K-Tork Pneumatic Actuators
    FM AS-Interface
    Modulation Operation

  - 8 – 20” Backwash Supply Valves
    Val-Matic Class 150B AWWA Butterfly Valves
    K-Tork Pneumatic Actuators
    FM AS-Interface
    Open-Close Operation

  - 8 – 24” Backwash Drain Valves
    Val-Matic Class 150B AWWA Butterfly Valves
    K-Tork Pneumatic Actuators
    FM AS-Interface
    Open-Close Operation

  - 8 – 8” Air Scour Valves
    Val-Matic Class 150B AWWA Butterfly Valves
    K-Tork Pneumatic Actuators
    FM AS-Interface
    Open-Close Operation

  - 8 – 8” Rewash / Filter-to-Waste Valves
    Val-Matic Class 150B AWWA Butterfly Valves
    K-Tork Pneumatic Actuators
    FM AS-Interface
    Open-Close Operation

  - 1 – Kaeser Duplex Air Compressor System
    Duplex 7.5 HP
    80 Gallon Receiver Tank

Filter Magic SCADA Computer System includes:

To the best of our knowledge, the existing SCADA computer located in the control room is primarily used to monitor the remote distribution sites and not used for plant SCADA functions. It is an older version XP computer with an older version of Wonderware HMI software on it with limited access and capability.

As a result, we are including in our filter control system proposal a new computer with software on it that will provide current and future benefits for operations.

- SCADA Computer
  - Windows 7 Professional 64 Bit Operating System
  - HP Z230 Mini-Tower Computer Workstation, I7-4790 3.6 GHz, 16 GB RAM, 1 TB HDD, DVD-RW, Intel HD 4600 Graphics, Wireless N PCIe Card
  - HP ProDisplay P221 21.5" LED Backlit Monitor
  - Uninterruptable Power Supply
- SCADA Software
  - GE Intellution iFIX Plus SCADA Software Version 5.8, licensed, unlimited and Runtime Only with Global Care
  - GE Intellution iHistorian – 100 I/O tags
  - Allen Bradley SLC 5/05E PLC Driver
  - XL Reporter
  - GE Intellution iFIX Plus SCADA Software upgradable to a fully redundant SCADA system
- Ethernet Switch
  - 5-Port 10/100/1000 Switch
- Full set of HMI screens to monitor, control, trend, alarm and report on all aspects of the filter control system.
  - Automatic, semi-automatic and manual control
  - Fully automatic backwash queue
- Historical data collection thru iHistorian software on a 1 TB hard drive for turbidity, flow, LOH and level for each filter for a minimum of seven (7) years.
- Trends
  - Historical and real-time trends for each filter showing turbidity, flow, LOH and level
  - One client specified trend
- Reports
  - Daily 15-minute Effluent Turbidity Report for all filters
  - Monthly Flow Summary report for all filters
  - Backwash Summary Report for each backwash event
  - One client specified report
- Two (2) days of Training
- The Filter Magic SCADA Computer System and software has sufficient capacity and performance capability to be expanded and integrated to include a complete plant SCADA system in the future.
  - The GE Intellution iFIX Plus SCADA Software accommodates unlimited inputs and outputs (I/O).
  - The GE Intellution iHistorian software accommodates 100 I/O tags 32 of which are being used for the filter control system. The iHistorian software can easily be upgraded from 100 I/O tags to 500 tags at any time in the future.

Our Proposal Does Not Include:

- Power for computer system
- Ethernet connectivity between computer system and filter control system
- Printer for SCADA computer
- 6 - Filter Effluent Turbidity Transmitters
- Backwash ROF 18" Valve w/ Modulating Ktork Pneumatic Actuator & Positioner
- Backwash ROF 18" Venturi & Transmitter
- Instrumentation, flow meters, valves, actuators and control systems not listed above
- Installation of valves, actuators, air compressor, etc.
- Installation of filter consoles or panels
- Providing or installing an air supply system from air compressor to valves
- Providing or installing conduit and wire
- Installing instrumentation and related sample and drain lines
- Termination of power, instrumentation & discrete signals
- Termination of Filter Magic Master Control Panel

Option Adders:

- Filter Magic Remote Access System that provides a client with the capability to remotely monitor the filter control system and the entire plant SCADA system from anywhere on the plant property through WiFi or cellular communication technology or remotely anywhere through cellular communication technology.

  Lump Sum $ 9,900.00

  Filter Magic Remote Access System includes:

  - Two (2) Remote Access Tablets
    - Apple iPad Mini 3 with iOS 8, 64 GB memory, built-in WI-FI and Cellular Communications, 2-year AppleCare+ protection plan, Verizon iPad nano-SIMM card, Hard Case
    - Engraving
      - Line 1 Property of Fayette County Water System, Georgia
      - Line 2 Phone Number
  - Remote Access SCADA Software
    - GE Intellution iClient WebSpace Remote Access Software located on Filter Magic SCADA computer, licensed for two (2) remote access devices
    - Additional remote access licenses are available at a reasonable cost.
    - Remote access software will work on any digital device with iOS, Android and browser-based operating systems

  Filter Magic Filter System Remote Access System does not include:

  - Plant-wide WiFi communication technology
  - Cellular communication technology

- 1 - Backwash ROF 18” Venturi & Transmitter for Backwash VFD Pump System
  Lump Sum $ 15,500.00

- 1 - Backwash ROF 18” Venturi w/ Transmitter and 18” Valve w/ Modulating Ktork Pneumatic Actuator/Positioner for Backwash Fixed Speed Pump System
  Lump Sum $ 25,600.00

- 4 - NEMA 12 Filter Magic “Slave” Filter Control Consoles (FCC)
  Lump Sum $ 42,000.00

  Each “Slave” FCC shall have identical OIT and software as “Master” FCC, shall be powered by the “Master FCC and shall communicate to the “Master” FCC over Ethernet.

  Our proposal does not include the additional cost for electrical work required to install slave FCCs.

- 8 - Single NEMA 12 Filter Magic Filter Control Consoles (FCC)
  Lump Sum $ 122,000.00

  Each single FCC shall have the exact same functionality as the base bid proposal with the exception that is shall be configured to monitor and control one filter each.

  Implementing this approach will require the necessary modifications to allow eight (8) separate and independent filter control systems including AS-I bus networks, single AS-I Panels in the Filter Pipe Gallery, additional electrical conduit and wire systems, additional engineering, fabrication, startup and warranty considerations.

  Our proposal does not include the additional cost for electrical work required to install single FCCs.

48 – Manual Gear Operators for all Valves Lump Sum $ 60,000.00

16 – Manual Gear Operators for all Influent & Effluent Valves Lump Sum $ 16,000.00

Please do not hesitate to call if further information is needed.

Very truly yours,

Mark W. Romers

Mark W. Romers
President

SECTION 43 12 01
COMPRESSED AIR SYSTEMS

PART 1 GENERAL

1.01 SCOPE AND RESPONSIBILITES

A. Owner has preselected and prenegotiated scope and price for the compressed air system, as indicated in Section 40 99 91, Filter Package Control System, from supplier Industrial Control System, Inc. for Work specified in Section 40 27 02, Process Valves and Operators, Section 40 99 91, Filter Package Control System, and herein.

B. The prenegotiated scope includes, but is not limited to, manufacturing and furnishing equipment and materials, delivering to the jobsite, installation of equipment, testing, providing various documentation, and providing services, as specified herein. The Contractor shall coordinate with the Supplier regarding details of the Supplier's scope.

C. Contractor's responsibilities shall include, but are not limited to, procurement, unloading/ receipt at the jobsite, storage, handling, coordination, and startup.

D. Owner's preselection and prenegotiation shall in no way be construed to change, in any material way, Contractor's responsibilities under the terms and conditions of this Contract.

1.02 REFERENCES

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

1. American Society of Mechanical Engineers (ASME): PTC 10, Compressors and Exhausters.
2. American Water Works Association (AWWA): E101, Vertical Turbine Pumps-Line Shaft and Submersible Types.
3. National Electrical Manufacturers Association (NEMA):
   a. 250, Enclosures for Electrical Equipment (1,000 Volts Maximum).
   b. MG 1, Motors and Generators.

1.03 DEFINITIONS

A. Standard Cubic Foot Per Minute (scfm): Volume flow rate of air at standard conditions of 60 degrees F, 14.7 psia, and 36 percent relative humidity.

1.04 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
   a. Make, model, weight, and horsepower of each equipment assembly.
   b. Manufacturer’s catalog information, descriptive literature, and specifications.
   c. Detailed mechanical and electrical drawings showing equipment fabrications. Include dimensions, size, and locations of connections to other Work.
   d. External utility requirements such as air, water, power, and drain for each component.
   e. Functional description of internal and external instrumentation and controls including list of parameters monitored, controlled, or alarmed.
   f. Control panel elevation drawings showing construction and placement of operator interface devices and other elements.
   g. Power and control wiring diagrams, including terminals and numbers.
   h. Manufacturer’s diagrams for air compressor piping.
   i. Seismic anchorage and bracing drawings and cut sheets, as required by Section 01 88 15, Anchorage and Bracing.

B. Informational Submittals:

1. Manufacturer’s recommended vibration limits of compressed air system.
2. Seismic anchorage and bracing calculations as required by Section 01 88 15, Anchorage and Bracing.
3. Field performance test procedures.
4. Manufacturer’s Instructions:
   a. Installation of equipment.
   b. Installation of vibration isolators.
5. Factory test reports of each test and inspection.
6. Field test reports for each functional and performance test of equipment.
7. Manufacturer’s Certificate of Compliance, in accordance with Division 1, General Requirements.
8. Manufacturer’s Certificate of Proper Installation, in accordance with Section 01 43 33, Manufacturers’ Field Services.
9. Operation and Maintenance Data: As specified in Section 01 78 23, Operation and Maintenance Data.

1.05 EXTRA MATERIALS

A. Furnish, tag, and box for shipment and storage the following spare parts and special tools:

1. V-Belts: One set per compressor type.
2. Intake Filter Cartridges: Three per compressor type.
3. Prefilter Replaceable Elements: Five for each compressor type.
4. Oil Filter Replaceable Elements: Three for each compressor type.
5. Special Tools: One set.

PART 2 PRODUCTS

2.01 EQUIPMENT

A. General:

1. Furnish air compressor as a complete system that includes compressor, motor, controls, and accessories.
2. Reference data sheet located at the end of this section as a supplement.

B. Rotary Screw Air Compressor:

1. Manufacturer and Product: Kaeser Model SX 7.5 AirCenter completely assembled with Kryosec Series refrigerated air dryer with automatic condensate Eco-drain, 80-gallon receiver tank, Clean Air Treatment filtration package with KOR60 filter at compressor outlet, and Eco-Drain 30 automatic drain traps. Including a condensate management KCF25 Oil/Water Separator with mounting kit.
2. Duplex air cooled, single-stage, rotary, oil-flooded, screw type with base mounted motor and V-belt drive with guard, including a convenient means for belt tensioning.
3. Rated for continuous operation at 105 degrees F at specified output without overheating.
4. Base mount and size to deliver 5 scfm at 80 psig under operating conditions of 14.7 psia and40 to 105 degrees F at compressor inlet, with rotary screw speed on male drive rotor of not more than 4,000 rpm.
5. Oil Filter: Full flow type with replaceable elements capable of at least 1,000 hours of operation between changes.
6. Oil Separator Assembly:
   a. Rated at 230 psig and equipped with an ASME safety valve set at 230 psig.
   b. Air leaving oil separator shall contain no more than 2 ppm of oil.
7. Oil Cooler: Fluid cooled, incorporate into oil system.
   a. Fouling Factor: 0.001.
   b. Cooling Air: Take from room ventilation.

8. Inlet Air Filter: Dry type.
9. Equip with pressure relief valve and vibration isolators.
10. Controls:
    a. Primary power disconnect switch.
    b. Combination motor starter with thermal overloads.
    c. ON/OFF/AUTO switch.
    d. Indicating lights.
    e. Elapsed time meter.
    f. Pressure switches.
    g. Fused control transformer sized to provide power for air dryer.
    h. Relays: Prewired and housed in NEMA 250, Type 12 panel mounted in convenient location on packaged compressor skid.
    i. Compressor shall start unloaded.
    j. Furnish automatic shutdown and illuminate alarm light mounted in control panel in event of:
        1) Loss of cooling water.
        2) High oil and air temperature.
    k. Manual Reset: Automatic shutdown.
    l. Pressure Switches:
        1) Mount in control panel with clearly labeled air-line connection installed to receiver.
        2) Bourdon tube actuated, double adjustment, SPDT mercury switch type rated for a minimum of 5 amps at 120V ac.
        3) Enclosures: NEMA 250, Type 12.
        4) Manufacturer and Product for Switches: Mercoid; Series DA-531.
        5) Initial Pressure Settings as follows:

Tag No.	**Open At**	**Close At**
M-310-1A and M-310-1B	70 psig rising	90 psig falling

    m. Furnish ON/OFF/AUTO control and ON status indication for air compressor.
    n. ON Mode:
        1) Compressor motor runs continuously.
        2) Compressor discharge rate shall modulate from 5 percent to 100 percent of compressor rated capacity.
        3) Control modulating valve by an adjustable pilot valve, and maintain a constant discharge pressure as set by pilot valve.
        4) Alarms: If in AUTO mode, enable in the ON mode.
    o. AUTO Mode:
        1) Receiver pressure starts and stops compressor.
        2) Start compressor on falling pressure when contact closes.
        3) Activate low pressure alarm light if pressure falls further.

4) As pressure increases, compressor stops on opening of contacts.
5) Activate high pressure alarm light by closure of contacts.
6) Furnish signal to activate the aftercooler control valve when compressor is operating.

p. Compressor Alarms:
1) Indicate at control panel.
2) Furnish normally open contacts for remote compressor FAIL indication when any alarm occurs.

q. Control Components:
1) Prewired.
2) Operate on a 120-volt ac power supply.

r. Power Supply: 460 volts, 3-phase, 60-Hz.

s. Panel and Controls: As specified in Section 40 99 90, Package Control Systems.

11. Motor: In accordance with NEMA MG 1.
a. Type: Squirrel-cage, energy efficient.
b. Enclosure: Open drip-proof.
c. Windings: Copper.
d. Duty Cycle: Continuous.
e. Temperature Rating: 40 degrees C ambient.
f. Horsepower: Minimum 7.5 HP.
g. Rpm: Maximum 1,800.
h. Volts: 460 volts
i. Phase: Three.
j. Frequency: 60-Hz.
k. Service Factor: 1.15.
l. Minimum Full-Load Efficiency: Not less than 93 percent.
m. Connected Load: Not to exceed motor nameplate horsepower rating at discharge pressures up to 230 psig.

C. Refrigerant Air Dryer:

1. Manufacturers and Products:
a. Kaeser; Kryosec Series.
2. Components:
a. Hermetically sealed refrigeration unit with air-cooled refrigeration condenser.
b. Air-to-refrigerant chiller and air-to-air precooler-reheater tube-in-tube, nonfouling heat exchanger(s).
c. Combination Separator-Filter: Capable of removing 100 percent of solid particles 3 microns in size and larger.
1) Separator: Stainless steel.
2) Filter: Coalescing type.
d. Equip dryer with an automatic drain trap for removing collected condensate.

e. Provide power on light and high temperature air warning light.
f. Utilize hot gas bypass system to maintain constant dew point from no-load to full-load conditions.
g. Provide fan cutout switch to stop fans during low ambient temperature conditions.

3. House entire unit in 18-gauge steel case suitable for wall mounting.
4. Electrical System: Thermal and overload protection with automatic reset.
5. Dryer Capacity: 35 degrees F pressure dew point at 100 psig with a flow of 56 scfm at a dryer inlet temperature of 100 degrees F saturated.
   a. Dryer Pressure Drop: Maximum 3.2 psig.
6. Refrigerant Compressor Drive: To be powered by AirCenter transformer.
   a. 115/230 volts.
   b. 1-phase.
   c. 60 Hz.

D. Equipment Tag Numbers:

1. Compressors: M-310-1A and M-310-1B.

E. Lifting Lugs: Provide suitably attached for equipment assemblies and components weighing over 100 pounds.

F. Equipment Identification Plates: Provide 16-gauge stainless steel identification plate securely mounted on each separate equipment component in a readily visible location. Plate shall bear 1/4-inch high engraved block type black enamel filled equipment identification number and letters indicated in this Specification.

G. Anchor Bolts: Galvanized, sized by equipment manufacturer, 1/2-inch minimum diameter, and as specified in Section 05 50 00, Metal Fabrications. Coat in accordance with Section 09 90 00, Painting and Coating.

2.02 ACCESSORIES

A. Air Receiver Equipment Number: T-310-1.

1. Horizontal welded steel ASME receiver.
2. Maximum Working Pressure: 230 psig.
3. Diameter: 20 inches.
4. Length: 63 inches.
5. Capacity: 80 gallons.
6. Fabrication: Welded carbon steelplate with ASME code required inspection openings.

7. Plate Thickness: For a maximum allowable working pressure of 230 psig plus a 1/16-inch corrosion allowance.
8. In accordance with ASME Code for Unfired Pressure Vessels.

B. Safety Valve:

1. Manufacturers and Products: Kaeser.
2. Fabrication: Bronze body, bronze base, disc with steel spring, top outlet, and malleable iron lifting lever.
3. In accordance with ASME Code for Unfired Pressure Vessels.

C. Automatic Drain Trap:

1. Manufacturer and Product: Kaeser Eco-Drain.
2. Inverted bucket type for liquid drainage.
3. Fabrication:
   a. Bucket and Leverage System: Stainless steel.
   b. Valve and Seat: Hardened chrome steel.
   c. Body and Cap: Cast iron.
4. Priming plug in cap and drain plug in body.
5. Provide 1/2-inch diameter NPT inlet and outlet connections.
6. Working Pressure: 230 psig.

D. Oil Removal Filters:

1. Manufacturer and Product: Kaeser KOR60.
2. One oil removal filter in the air piping, with matching prefilter as follows:
   a. Prefilter: A 5-micron cleanable element.
   b. Oil Removal Filter: Remove 99.9 percent of 0.3-micron lubricating oil from 100 psig air.
   c. Automatic drain valves on filters.
   d. Arrange filters so elements shall be replaced without removing filters from the line.

E. Air Pressure Reducing Valve:

1. Manufacturer and Product: Kaeser.
2. Fabrication: Cast iron body with neoprene diaphragm.
3. Capacity: Reduce pressure to 80 psig from upstream pressure of 80-230 psig.
4. Size: 2-inch IPS.

2.03 SHOP/FACTORY FINISHING

A. Prepare, prime, and finish coat in accordance with Section 09 90 00, Painting and Coatings System No. 5.

B. Furnish manufacturer's standard enamel finish, color as selected.

2.04 SOURCE QUALITY CONTROL

A. Factory Inspections: Inspect control panels for required construction, electrical connection, and intended function.

B. Factory Tests and Adjustments: Test all equipment and control panels actually furnished.

PART 3 EXECUTION

3.01 INSTALLATION

A. General: Install equipment on vibration isolators in accordance with manufacturer's instructions.

1. Piping: Equip with full-size flexible discharge connection, check valve, and isolation valve.

B. Air Compressor Piping:

1. Install in accordance with manufacturer's piping diagrams.
2. Pipe relief valve, tank drain, and separator drain to floor drain.

3.02 FIELD QUALITY CONTROL

A. Functional Tests: Conduct on each piece of equipment in the system.

B. Manufacturer's certification of proper installation.

1. Vibration Test:
   a. System shall not develop amplitudes of vibration in excess of manufacturer's recommendations.
   b. Test with units installed and in normal operation.
   c. If units exhibit vibration in excess of the limits specified, adjust or modify as necessary. Units which cannot be adjusted or modified to conform as specified shall be replaced.

C. Performance Test:

1. Conduct on each name unit assisted by manufacturer's representative.
2. Perform under actual or approved simulated operating conditions.

3. Test for a continuous 3-hour period without malfunction.
4. Perform with Engineer present.
5. Adjust, realign, or modify units and retest.

3.03 MANUFACTURER'S SERVICES

A. Manufacturer's Representative: Present at Site or classroom designated by Owner, 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.
3. 1 person-day for prestartup classroom or Site training and facility startup.

B. See Section 01 43 33, Manufacturers' Field Services and Section 01 91 14, Equipment Testing and Facility Startup.

END OF SECTION

SECTION 43 40 01
POLYETHYLENE STORAGE TANK

PART 1 GENERAL

1.01 WORK INCLUDED

A. This section covers the work necessary to furnish and install a bulk chemical storage tanks for sulfuric acid.

1.02 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.

1.03 DEFINITIONS

A. XLHDPE: Cross-linked high-density polyethylene.

1.04 DESIGN REQUIREMENTS

A. Manufacturer shall design a bulk chemical storage tank, 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.

B. Tank manufacturer must be capable of providing Underwriters Laboratories Listing for Nonmetallic Aboveground Tanks for Chemicals.

1.05 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 and handrail, 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. Foundation and Anchor Bolt Drawings: Drawings shall be provided that show all data and details required for design of the tank foundations including locations and dimensions for knockouts and embedded items, and the size, type, location, embedment and projection of anchor bolts.
   e. 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, etc.) shall be indicated for each of the applicable loading combinations found in the 1996 BOCA. Calculations for anchor bolt type, size, and location shall be indicated for the controlling load condition and BOCA Performance Category B.
   f. Tank data indicating pressure rating, diameter, straight shell lengths, overall lengths, wall thickness, and details of nozzle designs.

g. Tank capacity chart indicating gallons for each inch of depth and cumulative total from bottom.
h. Certified test data on representative samples of standard materials which demonstrate compliance with the physical properties specified herein.
i. Certified copy of all factory test results including gel tests, impact tests, and hydrostatic tests. Provide a listing of procedures used in testing.
j. 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.
k. All exceptions and any proposed revisions to the requirements of the Specifications shall be included with the Submittals.

2. Samples: Representative Samples of the high density cross-linked polyethylene with anti-oxidant resistant linear low density polyethlyene liner tank shall be provided.

B. Informational Submittals:

1. Fabricator's Certificate of Compliance with fabrication requirements.
2. Quality Assurance Inspection:
   a. Initial QA Inspection Report.
   b. Certification of Factory Testing.
3. Special shipping, storage and protection, and handling instructions.
4. Fabricator's written/printed installation and tank support instructions.
5. Manufacturer's Certificate of Proper Installation.
6. Operation and Maintenance Data: As specified in Section 01 78 23, Operation and Maintenance Data.

1.06 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 (i.e., ISO9001).

1.07 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 the 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.

1.08 SPECIAL GUARANTEE

A. Tanks shall have a minimum 2-year guarantee from the tank manufacturer, covering the complete cost of repair and replacement of the tanks (not including any costs associated with altering, removing, or demolishing the existing facility structure for such removal which shall be borne by Contractor) during the first 2 years of service, should leakage occur through the tank or the tank fittings, or should the tank or tank fittings show signs of fatigue or failure as determined by Engineer.

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 chemical.

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 to 100 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_2SO_4	1.71*

2.04 TANK DESIGN CRITERIA

A. Seismic Load: Category D.

B. Live Load: 200 pounds per square foot.

C. Concentrated Load: 300 pounds.

D. Special Loads: Design tanks for dead loads from all attached piping.

E. 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 with 1/8-inch inner wall reading no less than 65 percent and outer wall no less than 90 percent gel. Entire thickness must be at least 80 percent gelled.

D. The XLHDPE tanks shall be constructed using the rotational molding process.

E. Tanks shall be fabricated to the dimensions shown on the Drawings and as listed in the Tank Schedule:

Tank Schedule			
Equipment No.	**Minimum Capacity**	**Maximum Diameter***	**Sidewall Height***
Sulfuric Acid Tank (T-622-1)	3,900 gal	7’-10”	11’-2”
*Tank sizes are nominal sizes.			

F. 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
Flexural Modulus	D790	100,000 psi
Brittleness Temperature	D746	-130 degrees F
Heat Distortion Temp	D648	67 degrees C
Polyethlynene 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 a flexible connector, Integrally Molded Flanged Outlet (IMFO) Fitting Flange Mate Assembly 4-inch threaded PVC/C-276.

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 and overflow pipe attached to the tank.
2. Spacing of pipe supports shall be as recommended by the fabricator, but shall not be greater than 4 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: Teflon coated 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, Cages, and Handrail: Shall be in accordance with and as specified in Section 06 82 00, Glass-Fiber-Reinforced Plastic.

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 Teflon coated 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 jobsite and/or 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.

B. Manufacturer shall Certify in Writing:

1. Equipment has been provided in accordance with this Specification.
2. Equipment has been installed in accordance with the manufacturer's recommendations and inspected by a manufacturer's authorized representative.
3. Proper mechanical connections have been made.
4. Equipment is ready for startup and operation.

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

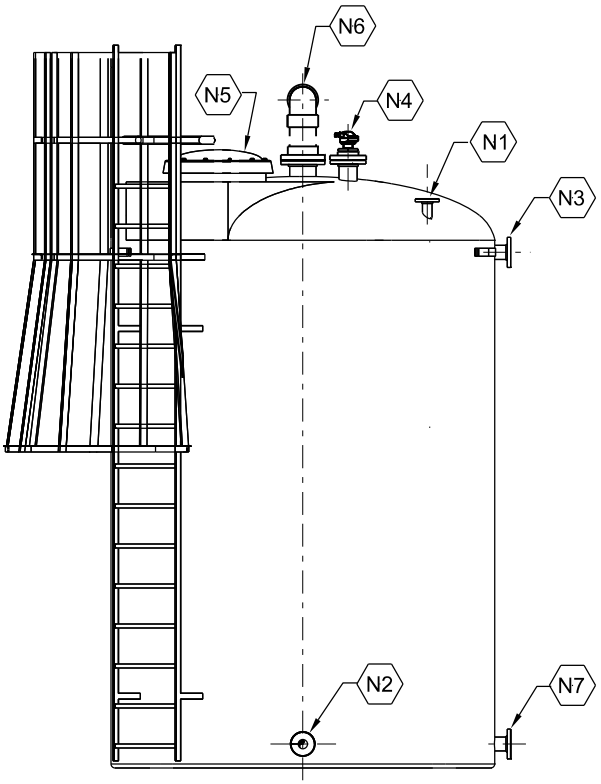
TDS-SULFURIC-ACID-T-622-1_497074.dgn

CH2MHILL®

TANK DATA SHEET

CROSSTOWN WTP IMPROVEMENTS

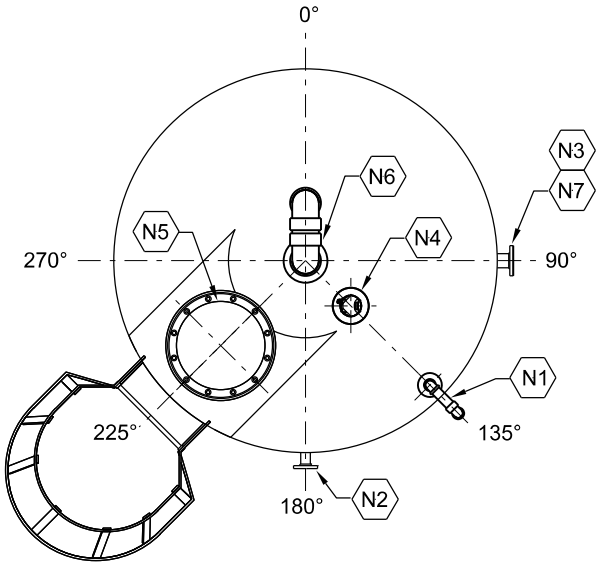
TANK NAME:	SULFURIC ACID STORAGE TANK		
TAG NUMBER(S):	T-622-1		
QUANTITY:	1		
SERVICE:	SULFURIC ACID (78%)	SPECIFIC GRAVITY:	1.7
pH RANGE:	< 1	TEMP. RANGE (°F):	MIN: 20° F MAX 100° F
DIAMETER:	7 FEET - 10 INCHES	STRAIGHT SHELL HEIGHT:	11 FEET - 2 INCHES
CAPACITY:	3900 GALLONS	STRAIGHT SKIRT HEIGHT:	N/A



COMPOSITE SECTION
NTS

NOTES:

1. HORIZONTAL NOZZLE ELEVATIONS TO CENTERLINE OF FITTING.
2. SEE SPECIFICATIONS FOR ADDITIONAL INFORMATION.
3. EXTEND FILL LINE (N1) 12" FROM TANK BOTTOM.
4. OUTLET (N2) AND DRAIN (N7) SHALL BE LOCATED AT INVERT OF TANK BOTTOM.
5. NOZZLES SHALL EXTEND 6" FROM TANK UNLESS OTHERWISE NOTED.
6. VENDOR TO PROVIDE INTERIOR FILLING LINE AS PART OF TANK.
7. ALL NOZZLES SHALL BE CONICAL.



PLAN
NTS

NOZZLES	MARK	QTY	SIZE	CL ELEV	CL RADIUS	NOTES
FILL	N1	1	2"	TOP	44"	(NOTE 3 & 6)
OUTLET	N2	1	4"	-	NA	IMFO (NOTE 4)
OVERFLOW	N3	1	2"	10'-9"	NA	
LEVEL INSTRUMENT	N4	1	8"	TOP	16"	
ACCESSWAY	N5	1	24"	TOP	30"	
VENT	N6	1	6"	TOP	CENTER	
DRAIN	N7	1	2"	-	NA	(NOTE 4)

DESIGN DATA
TANK LOCATION: OUTDOORS
WIND LOADS: NO SNOW LOADS: NO
TYPE OF TOP HEAD: DISH
TYPE OF BOTTOM HEAD: FLAT
LADDER REQUIRED: YES
PIPE SUPPORTS FOR INTERIOR PIPING: YES
PIPE SUPPORTS FOR EXTERIOR PIPING: YES
GRADUATED STANDPIPE: NO
HEAT TRACING: NO
INSULATION: NO
HANDRAILS: YES
TIE DOWN SYSTEM: YES
LATERAL RESTRAINT: YES
N/A = NOT APPLICABLE

SECTION 43 40 02
FIBERGLASS REINFORCED PLASTIC TANK

PART 1 GENERAL

1.01 SCOPE

A. This Work of this section includes the fabrication, delivery and installation of a Fiberglass Reinforced Plastic (FRP) Tank for storage of Purate ($NaClO_3$+ ½ H_2O_2, 40 percent sodium chlorate and 10 percent hydrogen peroxide) used in the production of chlorine dioxide.

1.02 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. E84, Standard Test Method for Surface Burning Characteristics of Building Materials.

1.03 DEFINITIONS

A. FRP: Fiberglass reinforced plastic.

1.04 DESIGN REQUIREMENTS

A. Design Loads: In accordance with Division 01, General 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.

1.05 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 inch of depth and cumulative total from bottom.
   f. Fabricator's detailed requirements for tank foundations.
   g. Recommended bolt torque for bolted FRP connections.
   h. Product data and wiring diagrams for tank heating panel system.
   i. Seismic anchorage and bracing drawings and cut sheets, as required by Section 01 88 15, Anchorage and Bracing.
2. Samples: Laminate sample representative of production quality of surface finish and visual imperfections.

B. Informational Submittals:

1. Complete design calculations for tanks, supports and appropriate accessories.
2. Seismic 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. Certification that supports and access nozzles have been coordinated with actual equipment being furnished.
8. Component and attachment testing seismic certificate of compliance as required by Section 01 45 33, Special Inspection, Observation and Testing.
9. Special shipping, storage and protection, and handling instructions.
10. Fabricator's printed installation and tank support instructions.
11. Manufacturer's Certificate of Proper Installation, in accordance with Section 01 43 33, Manufacturers' Field Services.

C. Contract Closeout Submittals: Service records for repairs performed during construction.

1.06 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 the State of Georgia.

1.07 DELIVERY, STORAGE, AND HANDLING

A. In accordance with Division 01, General 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.

1.08 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. Or equal.

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. Size and locate as specified by supplementary data sheet.
2. Gusset 4-inch or smaller nozzles with conical or plate type gussets. Larger nozzles shall be gusseted, if noted.
3. Finish flush with inside surface of tank, unless otherwise indicated.
4. 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.
5. Flanged Nozzles: Rated at 100 psi, with other dimensions and bolting corresponding to ASME B16.5 for 150-pound steel flanges.
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 nozzle to be of a "flush" design, where the invert 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 side 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 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 pipe and loading pipe.
   b. Spacing of supports shall be as recommended by fabricator, but shall not be greater than 4 feet on center.
   c. Pipe support shall allow removal of supported pipes.
   d. FRP complete with necessary bolts, nuts, and washers.
2. Level Probe Supports: FRP.

B. Platforms, Ladders, Handrails, and Kickplates:

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.

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 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.

2.07 SOURCE QUALITY CONTROL

A. Identify and retain cutouts. Engineer may select certain cutouts for testing for physical properties of laminate.

B. Factory Test Reports: Certify results, by signature, of the following:

1. Inspections.
2. Results of hydrostatic testing.
3. 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 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, Purate Tank- T-623-1.

END OF SECTION

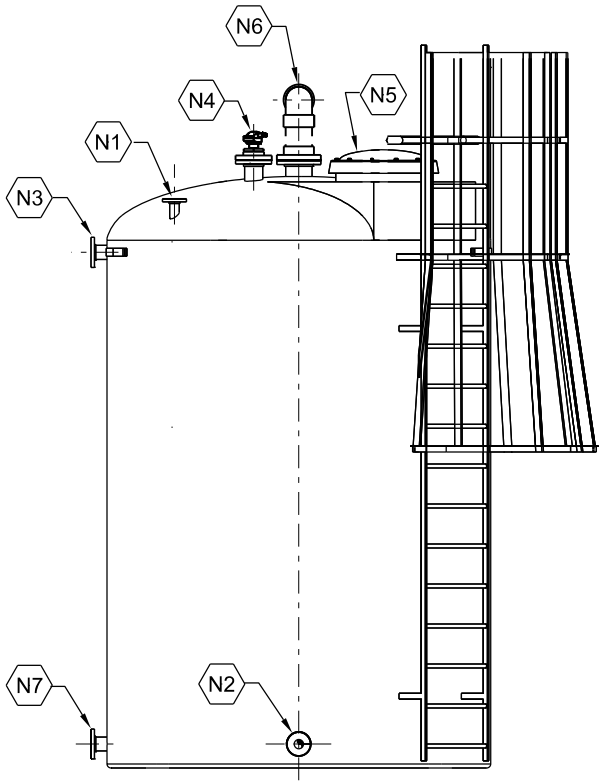
TDS-PURATE-T-623-1_497074.dgn

CH2MHILL®

TANK DATA SHEET

CROSSTOWN WTP IMPROVEMENTS

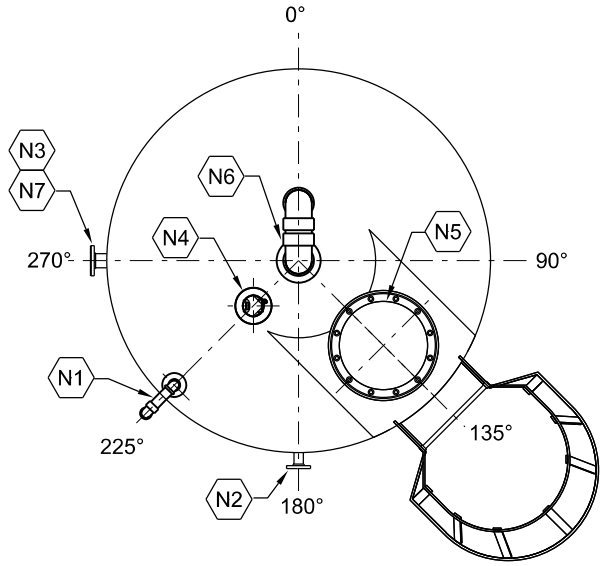
TANK NAME:	PURATE STORAGE TANK		
TAG NUMBER(S):	T-623-1		
QUANTITY:	1		
SERVICE:	PURATE	SPECIFIC GRAVITY:	1.377
pH RANGE:	1.7	TEMP. RANGE (°F):	MIN: 20° F MAX 100° F
DIAMETER:	8 FEET - 0 INCHES	STRAIGHT SHELL HEIGHT:	11 FEET - 0 INCHES
CAPACITY:	4100 GALLONS	STRAIGHT SKIRT HEIGHT:	N/A



COMPOSITE SECTION
NTS

NOTES:

1. HORIZONTAL NOZZLE ELEVATIONS TO CENTERLINE OF FITTING.
2. SEE SPECIFICATIONS FOR ADDITIONAL INFORMATION.
3. EXTEND FILL LINE (N1) 12" FROM TANK BOTTOM.
4. OUTLET (N2) AND DRAIN (N7) SHALL BE LOCATED AT INVERT OF TANK BOTTOM.
5. NOZZLES SHALL EXTEND 6" FROM TANK UNLESS OTHERWISE NOTED.
6. VENDOR TO PROVIDE INTERIOR FILLING LINE AS PART OF TANK.
7. ALL NOZZLES SHALL BE CONICAL.



PLAN
NTS

NOZZLES	MARK	QTY	SIZE	CL ELEV	CL RADIUS	NOTES
FILL	N1	1	2"	TOP	44"	(NOTE 3 & 6)
OUTLET	N2	1	2"	-	NA	(NOTE 4)
OVERFLOW	N3	1	2"	10'-9"	NA	
LEVEL INSTRUMENT	N4	1	8"	TOP	16"	
ACCESSWAY	N5	1	24"	TOP	30"	
VENT	N6	1	6"	TOP	CENTER	
DRAIN	N7	1	2"	-	NA	(NOTE 4)

DESIGN DATA
TANK LOCATION: OUTDOORS
WIND LOADS: NO SNOW LOADS: NO
TYPE OF TOP HEAD: DISH
TYPE OF BOTTOM HEAD: FLAT
LADDER REQUIRED: YES
PIPE SUPPORTS FOR INTERIOR PIPING: YES
PIPE SUPPORTS FOR EXTERIOR PIPING: YES
GRADUATED STANDPIPE: NO
HEAT TRACING: YES
INSULATION: YES
HANDRAILS: YES
TIE DOWN SYSTEM: YES
LATERAL RESTRAINT: YES
N/A = NOT APPLICABLE

SECTION 43 40 20
POWDERED ACTIVATED CARBON STORAGE AND FEED SYSTEM

PART 1 GENERAL

1.01 REFERENCES

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

1. OSHA, Safety standards concerning personnel protection against machinery and handling of dangerous chemicals.
2. Standard Building Code.
3. Applicable local, state, and federal codes.
4. AISC "Code of Standard Practice for Steel Buildings and Bridges."
5. AISC "Specifications for the Design, Fabrication, and Erection of Structural Steel for Buildings" and including the "Commentary of the AISC Specification."
6. AISC "Specifications for the Structural Joints Using ASTM A325 or A490 Bolts" approved by the Research Council of Riveted and Bolted Structural Joints of the Engineering Foundation.
7. ASCE 7-95 “Minimum Design Loads for Buildings and Other Structures.”
8. AWS "Code for Welding in Building Construction," and "Standard Qualification Procedure."
9. National Electrical Code.
10. NEMA ICS.

1.02 WORK OF THIS SECTION

A. This section covers the Work necessary to furnish, deliver, and install one powdered activated carbon (PAC) bulk bag and all feed system components specified herein and as shown on the Drawings.

B. Unit Responsibility:

1. The Work requires that the powdered activated carbon feed system 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 feed 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 01, General Requirements, which contains information and requirements that apply to the Work specified herein and are mandatory for this Project.

1.03 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
   a. Product Data:
      1) Make, model, and weight.
      2) Descriptive literature, specifications, dimensional layout, and identification of materials of construction.
      3) Painting/ Coating System(s): Manufacturer's descriptive technical catalog literature and specifications.
      4) Anchorage and bracing data sheets and drawings as required by Section 01 88 15, Anchorage and Bracing.
   b. Detailed Drawings:
      1) Structural, mechanical, and electrical showing equipment fabrications and interface with other items including dimensions, size, and locations of connections to other work, and weights of associated equipment.
      2) Structural and Mechanical: Details of PAC tower anchorage and support, hoist and trolley, hopper and feeder and all accessories.
   c. Hydraulic Calculations: Minimum average, normal maximum, and instantaneous flows and data.
   d. Certification of Structural Calculations: Letter of certification for structural design of mechanism, shall be signed and sealed by a Georgia Registered Professional Engineer.
      1) Include design calculations for all lifting lugs and connections. Calculations shall show stresses in all members and all components of each connection. The review of these calculations shall not relieve the fabricator of any obligation or responsibility contained in the Contract. Design shall conform to applicable parts of the current AISC Manual of Steel Construction. No skip welding shall be allowed.

e. Structural Loads: Static, dynamic, and torque reaction loads to be transferred into structure.
f. Component Manufacturer's Seismic Certificate of Compliance in accordance with Section 01 45 33, Special Inspection, Observation, and Testing.
g. External utility requirements such as air, water, power, drain, etc., for each component.
h. Functional description of internal and external instrumentation and controls to be supplied, including list of parameters monitored, controlled, or alarmed.
i. Power and control wiring diagrams, including terminals and numbers. See Section 40 99 90, Package Control Systems, for additional requirements.
j. Affidavits of compliance with referred standards and codes.
k. Motor Data: For each motor furnished, a certified motor data sheet for the actual motor or for a previously manufactured duplicate motor which was tested.
l. Components supplied to make unit suitable for outdoor service.
m. Proposed performance testing procedures for completed system.

B. Informational Submittals:

1. Designer's qualifications.
2. Anchorage and bracing calculations as required by Section 01 88 15, Anchorage and Bracing.
3. Manufacturer's Certificate of Compliance: Commercial products and factory-applied coating system(s).
4. Special shipping, storage and protection, and handling instructions.
5. Test procedures.
6. Test results, reports, and certifications.
7. Operation and Maintenance Data: As specified in Section 01 78 23, Operation and Maintenance Data.
8. Manufacturer's Certificate of Proper Installation.
9. Service records for maintenance performed during construction.

C. See Section 26 20 00, Low Voltage AC Induction Motors, for additional requirements.

D. See Section 40 99 90, Package Control Systems, for additional requirements.

1.04 QUALIFICATIONS

A. Designer: Georgia Registered Professional Engineer.

1.05 PRODUCT DELIVERY, STORAGE AND HANDLING

A. All equipment and materials shall be inspected against approved Shop Drawings at time of delivery. Equipment and materials damaged or not meeting requirements of the approved Shop Drawings shall be immediately returned to the system manufacturer for replacement or repair.

B. Equipment and materials shall be stored in a dry location and protected from the elements according to the system manufacturer's instructions.

C. Equipment and materials shall be handled in an approved manner according to the system manufacturer's instructions.

PART 2 PRODUCTS

2.01 GENERAL

A. The powdered activated carbon (PAC) bulk bag feeder shall be designed, detailed, fabricated, shipped, unloaded, and installed as shown on the Drawings, and as specified herein. The PAC bulk bag shall be supplied as a complete system including all feed system equipment and accessories necessary for safe and reliable operation. The PAC feed system will be housed beneath the bulk bag, as shown on the Drawings. The system air compressor shall be located within the bulk bag system.

2.02 MANUFACTURERS

A. Norit Americas, Inc.

B. Chemco Systems.

C. No "or-equal" or substitute products will be considered.

2.03 MATERIAL HANDLED

A. Powdered activated carbon with an "at rest" density of 22 to 28 pounds per cubic foot. The aerated density of the PAC is approximately 18 to 20 pounds per cubic foot.

2.04 SITE CONDITIONS

A. There will be 75 gpm of W1 carrier water provided to the PAC system for carrier/eductor water service. A minimum of 100 psi shall be available with pressures exceeding 140 psi on occasion.

1. If a booster pump and PRV are required for system operation, they are to be provided by the system manufacturer.

2.05 SYSTEM DESCRIPTION

A. The PAC bulk bag feed system shall consist of a complete and independent system for receiving and storing powdered activated carbon and feeding the slurry into two injection points. The two points will not be injected at the same time.

B. The bulk bag feed system shall consist of a bulk bag hoist, volumetric feeder, wetting cone, eductor, air fluidization nozzle, air compressor, and all associated valves and piping.

C. The bulk feed system shall be factory pre-assembled to the maximum practical extent. Factory assembly shall include tower assembly, prewiring, and piping.

D. The bulk feed system shall be designed for easy, safe and reliable performance. The tower shall be designed to hoist and support 1,000-pound bulk bags of powdered activated carbon. The feed system shall be capable of feeding PAC as a slurry to two injection point locations indicated on the Drawings.

E. The entire chemical system shall be designed, coordinated and supplied by one manufacturer. The system manufacturer shall furnish all equipment to complete a functioning integrated package. The system manufacturer shall also be responsible for installing and connecting all components within the limits of work described herein and shown on the Drawings. Components shall be supplied to make unit suitable for outdoor service.

F. The manufacturer shall be responsible for providing any additional materials above the PAC system slab to connect to the PAC slurry feed pipes, drains, water supply pipes, and electrical and control connections shown on the Drawings.

2.06 BULK BAG UNLOADER AND TOWER ENCLOSURE

A. The PAC bulk bag shall hold 1,000 pounds of PAC.

B. The bulk bag unloader shall include a trolley and hoist design rated for two tons. The frame shall be made of heavy-duty, 3-inch carbon steel box tube construction. The bulk bag unloader shall include an air fluidizing nozzle to promote material flow. All product contact surfaces shall be Type 304 stainless steel.

C. The system shall include a tower support structure capable of hoisting and supporting the 1,000-pound bulk bag. The tower shall be fabricated of powdered coated carbon steel. Minimum of 1-inch anchor bolt flanges. Stainless steel anchor bolts shall be appropriately sized in accordance with Section 01 88 15, Anchorage and Bracing. Provide anchor bolts in accordance with Section 05 50 00, Metal Fabrications. Anchoring to be coordinated with Contractor.

D. The hoist system shall be powered from CP-PAC, the PAC System Feed Control Panel.

E. Feed equipment with associated piping, instruments and the monorail and hoist equipment shall be mounted on the tower enclosure.

F. The tower shall be equipped with base plates and anchoring.

G. The frame and anchors shall be designed to be in accordance with Section 01 88 15, Anchorage and Bracing.

2.07 VOLUMETRIC FEEDER

A. Performance Requirements:

1. Feed Rate: 1.0 to 20 mg/L of PAC.
2. Plant Flows: 4.5 mgd to 13.5 mgd.
3. Production Requirement for maximum condition (flow and dose): 94 lb/hr of unfluidized PAC.

B. The feeder shall be the volumetric dry solids type for PAC.

C. The feeder shall employ a dissimilar speed, double concentric auger metering mechanism to ensure accurate, continuous, constant density material flow without flooding or bridging. The feeder housing shall be dust-tight with a minimum of 11-gauge steel construction. The feeder shall be heavy-duty and designed to provide easy cleaning without the need for removing the feeder from its mounting, or disassembling flexible connectors, hoppers, or removing the wetting cone. The feeder shall be constructed to provide complete access to its internal components by simply removing its discharge spout. The feeder’s double augers, drive shafts, and seal housing shall be constructed of Type 304 stainless steel; the seals shall be synthetic.

D. The double concentric auger metering mechanism shall consist of a solid shaft metering auger and a concentric, 10-inch diameter conditioning auger (intromitter). The larger conditioning auger (intromitter) shall span the full length of the feeder chamber and shall be driven at a slower speed than the smaller metering auger, thereby increasing the torque capability for low speed starting and eliminating the possibility of the metering auger tunneling in the material.

E. All chemical contact areas of the feeder including the double augers, seal assembly, and discharge cylinder shall be constructed of Type 304 stainless steel. Minimum sheet metal thickness shall be 11-gauge and all welds shall be continuous.

F. The feeder must include the ability to feed at a constant rate in pounds per hour or to follow a 4-20 mA analog signal.

G. The feeder shall be driven by a VFD with an allowable turndown of 20:1.

H. The feeder shall operate on a 480-volt, 60-Hz, three phase, 20 amps power supply.

I. The feeder shall have a volumetric metering accuracy of plus or minus 1 percent (error) for free flowing chemicals and a maximum of plus or minus 2 percent (error) for nonfree flowing chemicals based on a given number of consecutive one-minute samples.

J. Accessories:

1. Feeder Hopper: The feeder shall be supplied with an integral supply hopper to provide 3 cubic feet of storage capacity. The hopper shall be constructed of 11-gauge Type 304 stainless steel and be complete with a gasketed cover.
2. Storage Hopper Level Switch: The storage hopper shall have a high level switch mounted in the hopper to de-activate the air fluidizing nozzle for a preset time.
3. Wetting Cone: The wetting cone shall be fabricated of Type 316 stainless steel. A water line will connect to the wetting cone to promote PAC slurry flow into the eductor.
4. Wetting Cone Level Sensor: The wetting cone shall be equipped with high level probes to signal an alarm.
5. Equipment Identification Plates: A 16-gauge stainless steel identification plate shall be securely attached on the equipment in a readily visible location. The plate shall bear the ¼-inch die-stamped equipment identification number indicated in this Section and/or as shown on Drawings.

2.08 EDUCTOR

A. Sized to provide a maximum feed of 20 mg/L at 13.5 mgd.

2.09 AIR COMPRESSOR

A. Dual air compressor system including an 20 gallon receiving tank shall be included within the bulk bag feed system with a skid mounted panel with starters rated 480 volt, 40 amps, three-phase.

B. The compressor must be capable of providing 5 cfm at 100 psig of clean dry compressed air to the powdered activated carbon system.

C. Components supplied must be suitable for outdoor service.

D. Compressed air will be used for valve operation and air fluidization in the bulk bag.

E. Supplier to be responsible for all pneumatic tubing PTFE required for air fluidization and valve operation.

2.10 VALVES AND APPURTENANCES

A. Motive water valve, drain valve and PAC slurry valve to be PVC ball valves operated pneumatically.

B. Supplier to provide Schedule 80 SS304 slurry feed piping and motive water piping under bulk bag. Supplier shall coordinate with Contractor for proper interconnection with Contractor supplied piping.

C. Contractor is responsible for routing of the PAC slurry line from the bulk bag feed system out to the injection points as shown on the Drawings.

2.11 INSTRUMENTATION AND CONTROLS

A. General: See Section 40 99 90, Package Control Systems, for general instrumentation and control requirements. All instrumentation, control and electrical components provided under this section shall comply with the requirements of Section 40 99 90, Package Control Systems.

Panel No.	Name	NEMA Rating	Material
CP-PAC	PAC Feed System Control Panel	4X	Stainless

B. Panels: Provide the following panels:

1. Panels shall contain operator interface unit and local control devices, circuit breakers, VFD, 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 05, Conductors.

D. Operator Controls and Indications:

1. 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 feeder speed.

E. External Interfaces Between Package System (CP-PAC) and the Plant Control System:

1. For Chemical Feed System:
   a. Provide Contact Closure Output for:
      1) Feed System FAIL.
      2) Feed System ON Status.
      3) Feeder RUN COMMAND.
   b. Receive a Contact Closure Input for: Feeder RUN COMMAND.
   c. Receive an Analog Input for: PAC Production Setpoint (lbs/hr).
   d. Provide 4 to 20 mA Analog Output for: PAC production (lbs/hr).

F. Functional Requirements: Direct feed PAC slurry from the feed system. Feed based on analog signal for production setpoint and run command with feeder in REMOTE mode.

G. PAC feed system supplier shall provide their standard functional controls with a minimum of the following:

1. The control system shall include one programmable logic controller with sufficient I/O capability to control dosing system plus 20 percent spare I/O. The PLC shall be mounted inside Panel (CP-PAC).
2. Level sensors in volumetric feeder supply hopper shall monitor PAC level and initiate alarm when bag replacement is required. Air fluidization shall be initiated by low level in the feeder hopper.
3. The screw drive for the volumetric feeder shall be controlled by a VFD which allows 20:1 turndown ratio. Controller to be mounted in CP-PAC.

4. High vortex liquid level shall close water flow valves until condition has been corrected. High vortex level shall also stop feeder.
5. Provide SYSTEM TROUBLE signal when any alarm is initiated.
6. Provide level switches to monitor abnormal levels in the PAC hopper and feeder.

H. Power Requirements:

1. Power supply to CP-PAC will be 480-volts, 30 amp, three-phase, 60-Hz.

I. Special Requirements:

1. All solenoids and pneumatically operated valves shall be controlled from the PAC control panels.
2. In CP-PAC, provide a surge suppressor on the incoming 480-volt ac power supply. Suppressor shall be Square D J9200-9A. See Section 40 99 90, Package Control Systems.
3. Provide a differential pressure transmitter for measuring the differential pressure across the system.
4. As a minimum, provide all field instrumentation as shown on the Contract P&ID Drawings. Provide all additional instrumentation required to ensure that the system operates safely and functions properly.
5. All instrument housings shall be rated for at least NEMA 4X.

J. Factory Performance Test (FPT): Perform an unwitnessed, documented FPT on the control system. Submit documentation to Engineer prior to startup of the PAC system.

2.12 ELECTRICAL

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.

B. Drive Motors: All motors shall conform to the applicable portion of Section 26 20 00, Low Voltage AC Induction Motors.

C. Component parts of this system shall be factory wired to the PAC Feed System Control Panel. Provide wiring and conduit in accordance with Sections 26 05 05, Conductors and 26 05 33, Raceways and Boxes. Provide rigid galvanized steel conduit with liquidtight, flexible metal conduit for terminations requiring flexibility.

2.13 SPARE PARTS

A. Provide the following spare parts and special tools for the equipment specified herein:

Quantity	Item
1	Actuated 1-1/2-inch ball valve
1	Volumetric feeder auger
1	Point level switch
1	2-way solenoid valve
1	3-way solenoid valve
2	Complete sets of light bulbs for control panels Eductor
1	Educator
1	Feeder motor speed pickup
1	Touchup paint

2.14 INITIAL PAC SUPPLY

A. Provide PAC for all PAC system testing. Following successful system testing, provide six 1,000-pound PAC bulk bags required for 30 days of average supply. PAC shall meet the following specifications:

1. Product Specifications:
   a. Tannin Value, ppm: 350 maximum.
   b. Iodine Number: 500 minimum.
   c. Moisture, Percent as Packed: 8 maximum.
   d. Mesh Size:
      1) Percent through 100 Mesh (150 Microns): 99 minimum.
      2) Percent through 200 Mesh (75 Microns): 95 minimum.
      3) Percent through 325 Mesh (45 Microns): 90 minimum.
2. Provide PAC that meets Food Chemicals Codex, the AWWA B-600 Carbon Standards for powdered activated carbon, and is also listed under NSF Standard 61 for potable water. PAC shall be HYDRODARCO B as manufactured by Norit Americas, Inc. or equal.

PART 3 EXECUTION

3.01 GENERAL

A. Submit shop drawings to the Engineer for review in accordance with requirements of Division 01, General Requirements. Execute the work in accordance with the Shop Drawings appropriately stamped by the Engineer.

3.02 FABRICATION

A. See Section 05 50 00, Metal Fabrications.

B. Grind all exposed edges of welds smooth on steel column bases, and where indicated on the Drawings.

C. Welding: See Section, 05 05 23, Welding for requirements.

3.03 ASSEMBLY AND INSTALLATION

A. All components specified herein shall be assembled and installed in accordance with the manufacturers/suppliers written instructions.

3.04 PAINTING

A. The exterior fabricated metal surfaces of the PAC feed system shall be factory primed and finish painted prior to shipment to the field. Shop primer coat shall meet the requirements of System No. 5 as specified in Section 09 90 00, Painting and Coatings. Contractor shall field finish the coating as specified for System No. 5 in Section 09 90 00, Painting and Coatings.

B. Exposed metal surfaces of equipment specified herein shall be factory prepared, primed, and finish coated with the manufacturers' standard protective coating provided it meets or exceeds the requirements of System No. 5 as specified in Section 09 90 00, Painting and Coatings.

3.05 FIELD TESTS

A. The Contractor assisted by the equipment supplier's or manufacturer's representative shall conduct field tests.

B. Functional Test: Prior to equipment startup, all equipment shall be inspected for proper alignment, proper connections, and satisfactory performance.

C. Performance Tests:

1. For three days of 8 hours per day operation, observe operation of the equipment specified herein and repair any dusting or system leakage.
2. Perform tests to demonstrate that the system will deliver between 0 to 90 pounds per hour of unfluidized PAC at plus or minus 5.0 percent of desired output as based on sequential catch samples.

3.06 MANUFACTURERS' SERVICES

A. A manufacturer's representative for the equipment specified herein shall be present at the jobsite and/or classroom designated by the Owner for the minimum of person-days listed for the services hereinunder, travel time excluded; 3 trips minimum, not including installation time:

1. 2 person-days for installation assistance, inspection and certification of the installation.

2. 2 person-days for functional and performance testing.
3. 1 person-day for post startup training.

B. Training of Owner's personnel shall be at such times as requested by the Owner.

C. See Section 01 43 33, Manufacturers' Field Services, for additional requirements.

END OF SECTION

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 each 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 01, 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# AD-M8): M-620-1.

B. Water Booster Pump (Grundfos Model# CRE 5-13): P-621-1.

C. Chlorine Dioxide Analyzer: AE/AIT-620-6.

1.03 SUBMITTALS

A. General: Provide administrative, Shop Drawings, manuals, quality control, and contract close-out submittals in accordance with the requirements of Division 01, General Requirements, and as listed below.

B. Provide Shop Drawings as Follows:

1. Drawings and sections of skids including overall dimensions, locations of chemical pipe connection points, and water connection point. All drawings shall be stamped by a professional engineer licensed in the state of Georgia.
2. See Section 40 99 90, Package Control Systems for control panel submittal requirements.
3. See Section 40 90 01, Instrumentation and Control for Process Systems for instrumentation component submittal requirements.
4. Complete cut sheets and manufacturer information for any purchased subcomponents used by the manufacturer.

C. Quality Control 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 Performance Testing.

D. 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 01, 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.
2. Evoqua Water Technologies, Sarasota, FL, 941-355-2971.
3. Thornton, Musso & Bellemin, Zachary, LA, 225-654-4955.
4. No substitutes.

2.02 SERVICE CONDITIONS

A. Performance Requirements:

1. Dosage: 0.25 to 1.5 mg/l of chlorine dioxide.
2. Plant Flows: 4.5mgd to 13.5 mgd.
3. Production Requirement for maximum condition (flow and dose): 169 pounds per day of chlorine dioxide per generator.

B. The chlorine dioxide generators shall be located in the Chemical Building in the former Potassium Permanganate Room:

1. The ambient air temperature will be 40 degrees F to 90 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 Skids for carrier/eductor water service. A minimum of 130 psi shall be available at the eductor provided by the booster pump.

C. Application Point Information:

1. Raw Water Injection Point:
   a. Quantity: One at the Chemical Vault, upstream of Rapid Mix just outside the Chemical Building. Pressure at Injection Point: 8 psi.
   b. Length from Generation Point to Injection Point: 35 feet.
   c. Diameter of Piping: 1-1/4 inches.

2.03 SYSTEM PERFORMANCE REQUIREMENTS

A. Chlorine Dioxide Generators shall utilize the Following Chemicals:

1. Purate®.
2. Sulfuric Acid: (78 percent).

B. Each generator shall be capable of producing from 9.4to 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-ClO_2E. 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. Constructed on a 4 foot by 4 foot stainless steel skid.

B. Pump:

1. Equipment Tag No: P-621-1.
2. Capacity: 8.0 gpm at total head of 231 feet.
3. 1-1/2-inch NPT discharge connection.
4. Pump Manufacturer: Grundfos, Model CRE 5-13.

C. Motor:

1. Rating: 1.5 horsepower, 460 -volt, 3-phase.
2. Shall be totally enclosed, fan-cooled, 2-pole frequency controlled motor.

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 as part of chlorine dioxide generator control panel, CP-620.

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.

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. Provide anchor bolts in accordance with Section 05 50 00, Metal Fabrications. Anchoring to be coordinated with Contractor.

B. Chlorine dioxide generators shall include a nameplate, indicating the manufacturer, equipment tag number, and date of manufacture.

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-620	Chlorine Dioxide Generator Control Panel	4X	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 05, Conductors.

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).

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.
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.
3. Provide a flow meter for measuring plant water flow to generator. Flow meter shall be GF Signet Model 3-2536-PO.
4. Valves included in package shall be provided by manufacturer.
5. Provide a differential pressure transmitter for measuring the differential pressure across the eductor.
6. Power for the reactor, instrumentation, 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®/ sulfuric acid metering pump.
4. One metering pump repair kit.
5. One GF Signet 3-2536-P0 Water Flow Transmitter.

6. Two 1/2-inch FNPT BPTA-050-P Griffco CPVC Back Pressure Regulator.
7. Two 1/2-inch (15 DIN) Asahi Gaskets (Teflon/EPDM).
8. One 3/4-inch (20 DIN) Asahi Gaskets (Teflon/EPDM).
9. Four 1-inch (25 DIN) Asahi Gaskets (Teflon/EPDM).
10. Two 2-inch (50 DIN) Asahi Gaskets (Teflon/EPDM).
11. One 3-inch (75 DIN) Asahi Gaskets (Teflon/EPDM).
12. Four 3/8-inch Jaco CH906 Kynar Reactor Check Valves.
13. Two 1/2-inch CPVC True Union Ball Valves.
14. 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. Provide manufacturer's services and Manufacturer's Certificate of Proper Installation in accordance to Division 01, General Requirements, and as follows:

1. 1-person days and 1 trip by the chlorine dioxide generation system Manufacturer to assist the Contractor with the installation, startup, functional testing, and completion of Manufacturer's Certificate of Proper Installation.
2. 1-person days and 1 trip by the chlorine dioxide generation system Supplier 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

SECTION 44 42 19.04
ROTARY POSITIVE DISPLACEMENT BLOWER

PART 1 GENERAL

1.01 REFERENCES

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

1. American Gear Manufacturers Association (AGMA).
2. American National Standards Institute (ANSI).
3. ASTM International (ASTM):
   a. A48/A48M, Standard Specification for Gray Iron Castings.
   b. A395/A395M, Standard Specification for Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures.
4. National Electrical Manufacturers Association (NEMA).

1.02 DEFINITIONS

A. Absolute Discharge Pressure: Pressure in pounds per square inch absolute (psia) at the blower discharge flange in relation to jobsite barometric pressure.

B. BHP: (Shaft) brake horsepower is the standard curve horsepower required corrected for pressure, temperature and relative humidity at inlet conditions.

C. Discharge Pressure: Pressure in pounds per square inch gauge (psig) at the blower discharge flange at rated capacity.

D. Inlet Cubic Feet per Minute (ICFM): Volumetric rate of air at the inlet flange of the blower corrected to absolute pressure, temperature, and relative humidity. The pressure takes into account the inlet piping in filter pressure drops.

E. Pressure Rise: Pressure developed within the blower between the inlet and outlet flanges. It is the discharge pressure less the inlet pressure measured at the discharge and inlet flanges, respectively.

F. Standard Cubic Feet per Minute (SCFM): Volumetric rate of air measured in standard cubic feet per minute at 68 degrees F, pressure of 14.2 psig, and relative humidity of 36 percent.

1.03 SYSTEM DESCRIPTION

A. Blower system, featuring rotary positive displacement blower to supply air for the filter backwash process system.

B. Provide blower system, including, but not limited to, blowers, control panel, motors, drives, guards, drive couplings, baseplates, vibration isolators, supports, inlet silencers, discharge silencers, bypass silencers, relief valves, flexible connectors, spare parts, outside air filter, and miscellaneous appurtenances as necessary. Do not provide noise enclosures.

1.04 DESIGN REQUIREMENTS

A. Design equipment with due regard to safety of operation, accessibility, and durability of parts, and complying with applicable OSHA, state, and local safety regulations.

B. Seismic Requirements: In accordance with Section 01 88 15, Anchorage and Bracing.

C. Each blower will receive outside air coming through a piping gallery and discharge into a main air discharge header.

D. Intermittent and continuous operation in an indoor environment.

E. Blower(s) shall start no more than four times per hour when operating in intermittent service.

F. Blowers shall meet rated performance and sound level when operating at a maximum gear speed of 3,750 feet per minute. Operating speed shall not exceed 80 percent of rated speed.

G. Maximum Sound Pressure Level: 96 dBA, factory calculated, with inlet and discharge silencers, measured without a sound enclosure.

H. Performance Requirements:

Design Conditions	
Design Capacity, scfm	1570
Altitude, ft	843
Inlet pressure at compressor flange, psia	14.3
Inlet air temperature, degrees F (Guarantee Point)	100
Inlet air temperature range, degrees F	50 min to 105 max
Relative humidity, % (Guarantee Point)	50
Blower pressure rise required, psi	5.0

1.05 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
   a. Complete list of system components to be provided.
   b. Make, model, weight, and horsepower of each equipment assembly.
   c. Complete catalog information, descriptive literature, specifications, and identification of materials of construction.
   d. Standard and specialized equipment assembly cuts.
   e. System layout, installation, and placing drawings for equipment, drivers, and bases.
   f. Performance data for each type of equipment that will show compliance with specification requirements stated herein.
   g. Horsepower demand over the operating range of the blower.
   h. Detailed structural, mechanical, and electrical drawings showing the equipment fabrications and interface with other items. Include dimensions, size, and locations of connections to other work.
   i. Motor: See requirements of Section 26 20 00, Low-Voltage AC Induction Motors.
   j. Monitoring System:
      1) Catalog cuts of each blower control system component, including monitoring panel components.
      2) Wiring diagrams, including baseplate-mounted terminal junction box and equipment monitoring panel.
      3) Panel construction and face layout drawings.
   k. Seismic anchorage and bracing drawings and cut sheets, as required by Section 01 88 15, Anchorage and Bracing.
2. Samples: Color samples for finish coating. If paint manufacturer of finish coat differs from manufacturer of prime coat, provide both manufacturers' written confirmation that materials are compatible.

B. Informational Submittals:

1. Seismic anchorage and bracing calculations as required by Section 01 88 15, Anchorage and Bracing.
2. Manufacturer's Certificate of Compliance, in accordance with Section 01 43 33 Manufacturers' Field Services.
3. Factory calculated sound levels (dBA) of blower unit and silencers.
4. Factory calculated sound levels (dBA) of blower unit with silencers**.**
5. Identification of outside utility requirements for each component such as air, water, power, etc. Include operating parameters for required utilities.
6. Special shipping, storage and protection, and handling instructions.
7. Manufacturer's written installation instructions.

8. List of special tools, materials, and supplies furnished with equipment for use prior to and during startup and for future maintenance.
9. Suggested spare parts list to maintain the equipment in service for a period of 5 years. Include a list of special tools required for checking, testing, parts replacement, and maintenance with current price information.
10. Routine maintenance requirements prior to plant startup.
11. Test Reports:
    a. Factory test reports for blower and motor.
    b. Field test procedures.
12. Operation and Maintenance Data as specified in Section 01 78 23, Operation and Maintenance Data.
13. Manufacturer's Certificate of Proper Installation, in accordance with Section 01 43 33, Manufacturers' Field Services.

1.06 EXTRA MATERIALS

A. Furnish, tag, and box for shipment and storage the following spare parts, special tools, and materials:

Item	Quantity
Oil, synthetic	Enough for 1 complete change per unit
Inlet Filters	Enough for 1 complete changes per unit
Flexible Coupling	One complete set per unit
Drive V-Belts	One complete set per unit
Special tools required to maintain or dismantle	One complete set for each unit

B. Delivery: In accordance with Division 1, General Requirements.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. General:

1. Where possible, provide end products of one manufacturer in order to achieve standardization for appearance, operation, maintenance, replacement, and manufacturer's service.
2. Manufacture spare parts to United States standard sizes and gauges.

B. Materials, equipment, and accessories specified in this section shall be products of:

1. Aerzen: Model GM 50L.
2. Kaeser: Model FB 621C.
3. Or equal.

2.02 COMPONENTS

A. Blower:

1. Rotary positive displacement type, belt driven by horizontal electric motor.
2. Casing: One-piece construction, ASTM A48/A48M, Class 30B close-grain cast iron strongly ribbed to prevent distortion at the specified operating conditions. Separate headplates of cast iron.
3. Bearings:
   a. Each shaft and impeller assembly shall be supported by spherical or cylindrical anti-friction bearings sized for a minimum L10 rating of 100,000 hours.
   b. Drive end bearings shall be fixed to control axial location of impeller assembly.
   c. Bearings and gears shall be lubricated by a splash type lubrication system on both ends of the rotors.
   d. Provide each bearing with a positive lip type oil seal designed to prevent lubricant from entering air stream and a labyrinth seal on each shaft designed to reduce air leakage at point where shaft extends through headplate of blower casing.
   e. Make further provision to vent area between the two sealing systems to atmosphere to relieve excessive pressure on seals.
4. Impellers:
   a. Each impeller/shaft assembly integrally cast from high-strength ASTM A395/A395M Type 60-45-15 ductile iron with a minimum tensile strength of 60,000 pounds per square inch.
   b. Straight, three-lobe involute type, rotating in opposite directions in a common casing without rubbing, liquid seals, or lubrication.
   c. Positioned by timing gears to maintain proper clearances.
   d. Impellers and timing gears shall be mounted on shafts supported by antifriction bearings, fixed to control the axial location of impeller/shaft in the casing.
   e. Statically and dynamically balanced by removing metal from impeller body.
   f. Positively timed by a pair of accurately machined and carborized steel spur gears hardened to 58-62 Rockwell alloy timing gears manufactured to comply with AGMA. Gears mounted on shafts with tapered fit and secured by a locknuts.

5. Shafts:
   a. Alloy steel.
   b. Machine labyrinth seals into shaft to minimize air leakage.
6. Belt Drive:
   a. V-belt drive with automatic belt tension device.
   b. Minimum service factor of 1.4.
   c. Designed not to exceed allowable overhung load limits of blower and motor.
   d. Provide belt guard.

B. Motor:

1. Squirrel-cage ac induction type, meeting requirements of Section 26 20 00, Low-Voltage AC Induction Motors, and as specified herein.
2. Motor Horsepower: 60.
3. Nominal Speed: 1780 rpm, constant.
4. Rated Voltage: 460 volt, three-phase, 60-Hz.
5. Enclosure Type: TEFC as specified in Section 26 20 00, Low-Voltage AC Induction Motors.
6. Drive: V-belt drive.
7. Motor Efficiency: Premium efficiency as specified in Section 26 20 00, Low-Voltage AC Induction Motors.
8. Service Factor: 1.15.
9. Winding thermal protection: thermostats.
10. Motor winding space heater.

C. Blower Support:

1. Baseplate: Cast iron or fabricated steel mounted on concrete equipment pad as shown on Drawings.
2. Support Stand: Designed by manufacturer and shall be reinforced to withstand anticipated loadings of blower, motor, inlet and discharge silencers and associated piping.
3. Factory mount blower and motor as a package.
4. Provide vibration isolators to limit transmission of vibration to anchor points at floor.

2.03 ACCESSORIES

A. Air Inlet Filter:

1. Sized for one blower in operation.
2. Provide 98 percent removal efficiency on 10 micron and above.
3. Furnish with factory-mounted support legs
4. Support leg height shall be field coordinated by Contractor.

B. Inlet, Discharge and Bypass Silencers:

1. Designed to reduce pulsation from rotary lobe blowers at blower operating timing gear speed.
2. For timing gear speeds below transition speeds, use a multi-chambered reactive type silencer, and for timing gear speeds at or above transition speed, use a multi-chambered reactive and absorptive type silencer packed with hair-felt packing.
3. Inlet/Outlet Air Velocity: 3,000 feet per minute, maximum.
4. Pressure Loss: 6 inches of WC maximum, through silencer at design flow rate.
5. Inlet and outlet flanges shall match the piping size shown on Drawings and blower flanges. Flange drilling shall be 125-pound ANSI standard.
6. Provide drain coupling and plug.
7. Mount as shown on Drawings.

C. Flexible Connectors:

1. Pressure spool, single arch, expansion joint type with 125-pound ANSI flanges, sized to match blower flanges.
2. Operating Temperature Rating: 250 degrees F.
3. Install on each blower at inlet and outlet flange.
4. Thrust restraint rods on discharge if not otherwise restrained.
5. Manufacturers and Products:
   a. Mercer; Style 500.
   b. General Rubber; Style 1025.
   c. Vibraflex; PCS Series.

D. Check Valve:

1. Wafer type for each blower; installed in blower discharge piping downstream of silencer and relief valve.
2. Cast iron body, stainless steel pin and spring, and two semicircular cast iron or aluminum plates.
3. Seat: Viton or Silicone for high temperature operation. Elastomeric hinges will not be allowed.
4. Manufacturer: Techno Corporation.

E. Safety Relief Valve:

1. Cast iron weighted nonvibrating type with flanged connections. Sized to relieve entire discharge flow without overloading blower.
2. Furnish one for each blower.
3. Mount on discharge piping.

F. Temperature Sensor:

1. Provide HIGH discharge air temperature sensor, rated NEMA 4, for each blower.
2. Locate sensor directly after blower discharge.

G. Lifting Lugs: Provide suitably attached for equipment assemblies and components weighing over 100 pounds.

H. Equipment Identification Plates: Provide 16-gauge stainless steel identification plate securely mounted on each separate equipment component in a readily visible location. Plate shall bear 3/8-inch high engraved block type black enamel filled equipment identification number and letters indicated in this Specification.

I. Anchor Bolts: Galvanized, Type 316 stainless steel, sized by equipment manufacturer, 1/2-inch minimum diameter, and as specified in Section 05 50 00, Metal Fabrications. Coat in accordance with Section 09 90 00, Painting and Coating.

2.04 INSTRUMENTATION AND CONTROLS

A. Instrumentation and controls work of this section shall be in accordance with Section 40 99 90, Package Control Systems. External signal interfaces are required to interface with facility's PLC/ SCADA system as indicated on the drawings. Provide items not specifically called out which are required to implement functions required for proper system operation.

B. Shop/Factory Finishing:

1. Prepare, prime, and finish coat in accordance with Section 09 90 00, Painting and Coating System No. 6.

2.05 SOURCE QUALITY CONTROL

A. Blower Performance Test:

1. Notify Engineer at least 7 days prior to performing test.
2. Perform on the blower actually furnished in accordance with manufacturer's established criteria**.**
3. Test each blower for a minimum of 1 hour after stabilization at conditions near the performance ratings for mechanical integrity and flow performance.
    a. Perform at or above specified performance pressure rise.
    b. Tolerance on Flow: Plus or minus 4 percent, after correction to rated conditions.

4. Perform Slip Test in accordance with manufacturer's established criteria.
    a. Describe the testing configuration**.**
    b. Document operating conditions, temperatures, pressures, blower speed, etc.
    c. Complete slip calculations at test conditions**.**
5. Measure power consumption using a calibrated wattmeter.
6. Test Report: Confirm capacity and power, complete with data and calculations used in the test.

B. Motor Test: See Section 26 20 00, Low-Voltage AC Induction Motors.

PART 3 EXECUTION

3.01 INSTALLATION

A. In accordance with manufacturer's written instructions.

B. Install one check valve in the blower discharge piping, downstream of the silencer and safety relief valve.

C. Anchor Bolts: Accurately place using templates furnished by manufacturer and as specified in Section 05 50 00, Metal Fabrications.

D. Install blower package on vibration isolators and anchor bolts in strict accordance with manufacturer's written instructions.

3.02 FIELD QUALITY CONTROL

A. In accordance with Section 01 91 14, Equipment Testing and Facility Startup.

B. Functional Test: Prior to facility startup, conduct on each Blower System, assisted by manufacturer's representative, for correct rotation, proper alignment and connection, quiet operation, and satisfactory specified performance.

3.03 MANUFACTURER'S SERVICES

A. Manufacturer's Representative: Present at Site or classroom designated by Owner, for minimum person-days listed below, travel time excluded:

1. 1-person-day for installation assistance and inspection.
2. 1-person-day for functional testing and completion of Manufacturer's Certificate of Proper Installation.
3. 1-person-day for post-startup training of Owner's personnel.

B. See Section 01 43 33, Manufacturers' Field Services and Section 01 91 14, Equipment Testing and Facility Startup.

END OF SECTION

SECTION 44 43 30
FILTER MEDIA

PART 1 GENERAL

1.01 SCOPE AND RESPONSIBILITES

A. Owner has preselected and prenegotiated scope and price for the air scour piping (as indicated in Section 44 43 34, Filter Underdrain System), filter media, and the filter underdrain system from supplier AWI, Phoenix Filter Underdrain System for Work specified in Section 40 27 00, Process Piping, Section 44 43 34, Filter Underdrain System, and herein.

B. The prenegotiated scope includes, but is not limited to, manufacturing and furnishing equipment and materials, delivering to the jobsite, installation of equipment, testing, providing various documentation, and providing services, as specified herein. The Contractor shall coordinate with the Supplier regarding details of the Supplier's scope.

C. Contractor's responsibilities shall include, but are not limited to, procurement, unloading/ receipt at the jobsite, storage, handling, coordination, and startup.

D. Owner's preselection and prenegotiation shall in no way be construed to change, in any material way, Contractor's responsibilities under the terms and conditions of this Contract.

1.02 REFERENCES

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

1. American Water Works Association (AWWA): B100, Filtering Material.
2. NSF International (NSF):
   a. NSF/ANSI 61, Drinking Water System Components- Health Effects.
   b. NSF/ANSI 372, Drinking Water System Components- Lead Content.

1.03 SUBMITTALS

A. Action Submittals:

1. Shop Drawings: Submit not less than 30 days prior to shipment manufacturer's product information, including grain size ranges for each fine media layer specified. Fine media sizes shall be in millimeters.

2. Samples: Submit Sample of media material following delivery of shipment.

B. Informational Submittals: Submit gradation test results of fine media, including sieve analysis prior to loading and shipment.

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. Fine Media (Dual): AWI, Sandy, UT; Phoenix Filter Underdrain System. No “or-equal” or substitute products will be considered.

2.03 FINE MEDIA-DUAL MEDIA FILTERS

A. The filters shall use dual media with total depth of 36 inches. The media shall consist of 12 inches of sand overlaid by 24 inches of puracite. These depths shall be confirmed after backwashing and draining of the media and scraping and removal of fines and debris.

B. Dual Media of Puracite Coal and Silica Sand for Water Filters: Clean, hard, durable particles in conformance with AWWA B100a, modified as follows:

1. Puractie coal of specific gravity 1.38- 1.40, effective size 0.8 to 0.9 millimeter, uniformity coefficient not more than 1.45**,** and a hardness of 2.7 to 3.0 (MOH scale).
2. Silica sand of specific gravity 2.65, effective size 0.40 to 0.50 millimeter, and uniformity coefficient not more than 1.4.

2.04 SOURCE QUALITY CONTROL

A. Owner will test Samples in accordance with procedures specified in AWWA B100a.

PART 3 EXECUTION

3.01 INSTALLATION

A. General:

1. Do not permit workers to walk or stand directly on gravel or other materials that are less than 1/2 inch in diameter. Use boards that will sustain workers' weight without displacing the material.
2. Before fine media is placed, mark top of all layers on side of filter.
3. The underdrain system shall be inspected and tested before the commencement of the media placement.
4. Sand and puracite media shall be transported, delivered, and placed in a careful manner to exclude all dust, dirt, or deleterious material and to prevent physical damage to the particles. The Contractor shall designate an area onsite, with the approval of the Owner, for storage of all media. As a minimum requirement, bagged material shall be stored on pallets and covered with plastic for protection from sunlight and weather. Bulk material shall be installed in a bin and covered with plastic or stored in a shed as approved by the Engineer. Each size and type of media shall be stored separately. Under no circumstance shall material be removed from the bags prior to placement in the filter, except for sampling.
5. All media shall be handled and stored to prevent contamination from foreign matter. In the event any such material, equipment, and supplies are lost, stolen, damaged, or destroyed prior to final inspection and acceptance, the Contractor shall replace the same without additional cost to the Owner.
6. Installation and preparation of the filters for service shall be in accordance with AWWA B100 unless specifically noted otherwise herein.

B. Fine Media:

1. Transport and place fine media carefully to prevent contamination of any sort.
2. Replace contaminated media with clean media.
3. Level fine media by hand to within plus or minus 6 inches of the appropriate mark prior to backwashing.
4. Install in following sequence:
   a. Place 12 inches of silica sand and level.
   b. Backwash bed a minimum of three times, and remove surface fines by scraping after each washing.
   c. Replace scrapings with new material after each washing to obtain the required depth.
   d. Place 24 inches of puracite coal and finish off smooth to proper elevation.

e. Backwash bed three times, and remove minimum of 1/2 inch of surface fines by scraping after each washing.
f. Replace scraping with new material after each washing to obtain the required depth.
g. Backwash and remove surface fines until gradation is in accordance with specified bed design.

5. Final depth of fine media after washing and scraping shall be 36 inches.

3.02 DISINFECTION

A. After installation of media is completed, disinfect media in accordance with the requirements of Section 33 13 00, Disinfecting of Water Utility Distribution.

3.03 MANUFACTURER'S SERVICES

A. See Section 44 43 34, Filter Underdrain System for manufacturer's services to be provided for the total filtration system scope.

END OF SECTION

SECTION 44 43 34
FILTER UNDERDRAIN SYSTEM

PART 1 GENERAL

1.01 SCOPE AND RESPONSIBILITES

A. Owner has preselected and prenegotiated scope and price for the air scour piping (as indicated in the attached proposal), filter media, and the filter underdrain system from supplier AWI, Phoenix Filter Underdrain System for Work specified in Section 40 27 00, Process Piping, Section 44 43 30, Filter Media, and herein.

B. The prenegotiated scope includes, but is not limited to, manufacturing and furnishing equipment and materials, delivering to the jobsite, installation of equipment, testing, providing various documentation, and providing services, as specified herein. The Contractor shall coordinate with the Supplier regarding details of the Supplier's scope.

C. Contractor's responsibilities shall include, but are not limited to, procurement, unloading/ receipt at the jobsite, storage, handling, coordination, and startup.

D. Owner's preselection and prenegotiation shall in no way be construed to change, in any material way, Contractor's responsibilities under the terms and conditions of this Contract.

1.02 GENERAL

A. There shall be furnished a filter underdrain system for a total of 8 filter cells, with each filter cell shall be 28 feet long by 14 feet wide. The filter underdrain system shall be installed in the filter cells as shown on the Contract Drawings. The filter underdrain system will be designed to support the filter media without the need for filter gravel, collect filtered water, evenly distribute air for filter media cleaning, and evenly distribute backwash water

B. Like items of equipment herein shall be the end product of one manufacturer in order to achieve standardization for operation, maintenance, spare parts, and manufacturer's services.

C. The Contractor is advised that the Drawings show only the general arrangement for the filter underdrain system and do not show complete details to properly interface the filter underdrain system with the surrounding filter structures. The Contractor is also advised that such details:

1. Shall be designed by the filter underdrain system Supplier.

2. May require modifications to the surrounding structures for Filters Nos. 1 - 8.

D. The Contractor shall obtain, from the filter underdrain system Supplier such written interface requirements, installation details, and recommendations as are necessary to properly interface the filter underdrain system with all surrounding structures and to provide a complete, functional, and operable air scouring, filter underdrain system.

1.03 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 Flange Fittings NPS 1/2 Through NPS 25 Metric/Inch Standard.
2. ASTM International (ASTM):
   a. ASTM 304, American Society for Testing and Materials - Pipe Specifications.
   b. A380, Standard Practice for Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment, and Systems.
   c. C881/C881M, Standard Specification for Epoxy-Resin-Base Bonding System for Concrete.
   d. C882/C882M, Standard Test Method for Bond Strength of Epoxy-Resin Systems Used with Concrete by Slant Shear.
3. NSF, International: 61, Drinking Water System Components—Health Effects.

1.04 SYSTEM DESCRIPTION

A. Design Requirements:

1. Design filter underdrain system, including, but not limited to, the underdrain laterals and drop legs, air scour header, and air scour risers.
2. Compatible with filter media being supplied; refer to Section 44 43 30, Filter Media.
3. Flow:
   a. Produce uniform air and water flows throughout filter box.
   b. Flow uniformity per square foot of filter underdrain area shall be as required to permit efficient and effective operation during filtration and backwashing.
   c. There shall be no localized areas with flow rates which would cause mounding, lateral displacement, or other deleterious disturbances in filter media.

d. Size air scour header and risers to produce uniform air flows throughout filter bay.

4. System shall ensure operating characteristics have long-term stability and resistant to the following:
   a. Corrosion.
   b. Changes in head loss.
   c. Changes in flow uniformity.
   d. Other effects which would over time cause loss of efficiency or effectiveness of operation.
5. System Design Loads:
   a. Withstand net downward loading of not less than 1,400 psf, plus system's own dead weight.
   b. When installed, withstand net internal loading (burst pressure) of greater than or equal to twice the maximum head loss experienced at maximum backwash rates and not less than 5 psig. No credit shall be taken for weight of filter media.
   c. Withstand specified loadings, including anchorages and supports.
   d. Address loads incurred during shipment, delivery, storage, handling, installation, and operation.
6. Support and Restraint:
   a. Underdrain and air scour header and drop legs shall be anchored as required to resist buoyant forces and dynamic forces during operation.
   b. Underdrain laterals shall not require support or restraint to resist specified burst pressure.
   c. Safety Factor: 2.0, minimum, to account for transient pressures which may occur during initiation and termination of air and water flows during backwash.
   d. Filter air scour header assemblies shall be designed to be supported inside flume.

B. System Performance Requirements:

1. As installed, shall satisfy the following criteria for minimum acceptable flow uniformity. Maldistribution of air and water flows during backwash, for all indicated flow conditions, shall not exceed:
   a. Water: Plus or minus 5 percent of average gpm per square foot of filter underdrain area.
   b. Air: Plus or minus 10 percent of average scfm per square foot of filter underdrain area
2. Evenly distribute air, water, and combined air/water flows and perform satisfactorily when operated under the following conditions:
   a. Filtration (Downflow) Mode: Water (filtrate) at rates up to 5 gpm per square foot of filter underdrain area.

b. Backwash (Upflow) Mode:
   1) Air Rate:
      a) 4 scfm per square foot of filter underdrain area for air wash only.
      b) 4 scfm per square foot concurrent with water at rates of between 2 and 6.5 gpm per square foot while overflowing backwash troughs.
   2) Water Rates: Up to30 gpm per square foot of filter underdrain area.

3. Total water flow head loss across underdrain system, shall not exceed the following:
   a. 36 inches water column (WC) of head loss when supplied with water flow of up to 25 gpm per square foot at 75 degrees F in backwash mode.
   b. 5 inches WC of head loss when supplied with water flow of up to 5 gpm per square foot at 75 degrees F in filtration mode.
4. Water flow head losses across underdrain system shall include losses associated with underdrain and equalizing or secondary flume inside filter bay.
   a. Head losses shall include losses between lower gullet wall opening to just above top of underdrain.
   b. Head losses exclude static head of water above underdrain as well as losses through media.
5. Air flow head loss across filter air scour header and drop legs, and underdrain laterals shall not exceed the following:
   a. 12 inches WC of head loss when supplied with concurrent air and water flows of up to 4.0 scfm per square foot of air flow and up to 6.5 gpm per square foot of water flow at 75 degrees F in backwash mode.
6. Air flow head losses across filter air scour header, drop legs, and underdrains shall include losses associated with air scour header assemblies and underdrain.
   a. Head losses shall include losses from upstream flange on air scour header within filter basin to just downstream of (above) distribution orifices in top of underdrain.
   b. Head losses exclude static head of water above underdrain**.**

1.05 SUBMITTALS

A. Action Submittals:

1. Manufacturer’s catalog cuts and technical literature describing proposed filter underdrain system.
2. Shop Drawings: Scaled and dimensioned drawings showing layout and configuration.

3. Written interface requirements, installation details, and recommendations as are necessary to properly interface filter underdrain system with surrounding structures. Provide guidance in order for filter structure to be modified to accommodate underdrain system if needed.
4. Details of design and operating characteristics of proposed filter underdrain system. Address full range of flow conditions. Indicate pertinent physical relationships (location, relative size) among various air and water orifices, including those in lower gullet walls**.**
5. Submittal data shall include the following:
    a. Materials of construction.
    b. Head loss data for air, water, and combined air/water flows.
    c. Maximum percentage of flow maldistribution within filter for air, water, and combined air/water flows.
    d. Cross-sectional areas for flow of air and water and resulting velocities at pertinent points (e.g., gullet, lateral, orifices) throughout underdrain system (i.e., from inside lower gullet to just above media support cap).
    e. Relative magnitudes of entrance, transport, metering, and discharge losses.
    f. Other data necessary to demonstrate conformance with requirements of Contract Documents.

B. Informational Submittals:

1. Written confirmation that filter media is compatible with underdrain system.
2. Test reports showing conformity with hydraulic and pneumatic flow. Address full range of flow conditions.
3. Certification that filter underdrain system will satisfy specified hydraulic and pneumatic conditions and provide even distribution of air, water, and combined air/water flow at specified flow rates as fed in arrangement shown on Drawings.
4. Design calculations showing structural design requirements, including anchor bolt sizing. Structural calculations shall be stamped and signed by structural engineer registered in state of the Project.
5. Documentation showing NSF 61 certification of underdrain components, including sealing compounds, caulks, and other materials.
6. Proposed method of testing installed system.
7. Field Test Reports: Describe units tested, type of test, test set ups, procedures, instrumentation, flow rates, pressures, levels, and other data and results as required to demonstrate items tested meet specified requirements.
8. Certificate of factory tests and test results prior to delivery of underdrain system components.

9. Written interface requirements, installation details, and recommendations as necessary to properly interface filter underdrain system with surrounding structures.
10. Manufacturer's installation instructions and details.
11. Manufacturer's written confirmation filters have been satisfactorily prepared for installation of filter underdrain system.
12. Manufacturer's Certificate of Proper Installation, in accordance with Section 01 43 33, Manufacturers' Field Services.
13. Operation and Maintenance Data as specified in Section 01 78 23, Operation and Maintenance Data.

1.06 QUALITY ASSURANCE

A. Qualifications:

1. Manufacturer shall have, as a minimum, 15 successful installations in the United States of a complete underdrain system.
2. Manufacturer's representative for field services shall be a direct employee of filter underdrain system manufacturer and shall have minimum of 5 years' experience installing type of underdrain system specified herein.

B. Certification: Materials used in contact with water and backwash air shall meet NSF 61.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Equipment shall be boxed, crated, or otherwise protected from damage and moisture during shipment, handling, and storage and adequately marked for ease of erection.

B. Equipment shall be protected from exposure to corrosive fumes and kept dry.

C. Store products in a manner that prevents damage and in an area that is protected from the weather.

1.08 SPECIAL GUARANTEE

A. Provide 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 underdrain material found defective during a period of 5 years after the date of Substantial Completion. Duties and obligations for correction or removal and replacement of defective Work shall be as specified in the General Conditions.

PART 2 PRODUCTS

2.01 STAINLESS STEEL LATERAL FILTER UNDERDRAIN SYSTEM

A. Manufacturers:

1. Where a manufacturer's standard equipment name or model number is listed, equipment system shall be provided as modified to conform to performance, functions, features, and materials of construction as specified herein.
2. Materials and products specified herein shall be selected and supplied by filter underdrain system manufacturer, unless specified otherwise.
3. Materials, equipment, and accessories specified in this section shall be products of:
   a. AWI, Sandy, UT; Phoenix Filter Underdrain System.
4. No "or-equal" or substitute products will be considered.

B. General:

1. Series of stainless steel laterals connected and sealed to stainless steel inlet/outlet flow distribution devices.
2. Laterals shall be evenly spaced, anchored and sealed onto concrete floor of each filter.
3. Gaskets and Sikaflex 1a sealant shall be NSF 61 approved.

C. Laterals:

1. Consisting of one primary water collection/backwash distribution conduit and one primary air scour distribution conduit in separate compartments.
2. The lateral orifices shall be sized and located to provide uniform distribution of water.
3. Designed to independently distribute air and water during filter backwashing.
4. Type 304 stainless steel.
5. One-piece construction with no shop bolted or riveted media barrier panels or other independent media barrier devices attached.
6. Locate individual variably sized secondary distribution orifices within each lateral to control distribution of backwash water flows along entire lateral length.
7. A calculated number of slots shall control distribution of air scour flow directly from air conduit into filter media.
8. Media Retaining Slots: Cut directly into sides of laterals to support filter media without need for filter gravel, while allowing passage of water for filtered water collection and backwashing.

D. Lateral Feed Orifices: Each lateral to discharge filtered water and provide backwash water through a single primary orifice located 1 inch, maximum, above stainless steel lateral base.

E. Equipment Flanges: Comply with ASME B16.1, Class 125 or ASME B16.5, Class 150, unless otherwise indicated.

F. Anchorage:

1. Use hold down clamps (e.g., standard, filter edge, flume end, and wall seal).
2. Anchor bolts shall be epoxy bond type, sized per manufacturer's recommendations.
3. Type 304 stainless steel.

2.02 SERVICE CONDITIONS

A. Filter underdrain system shall operate in dual media gravity filters.

B. Backwashing regime for filters uses air scouring and includes air only, combined air/water, and water-only steps.

C. Filter Influent:

1. Will be settled water.
2. Will be chlorinated. Maximum free chlorine residual is 1 milligram per liter.

D. Filter backwash water will be filter effluent supplied from clearwell containing 2 milligrams per liter of chlorine.

E. Temperature:

1. Filter influent and backwash water are expected to be approximately 50 to 90 degrees F.
2. Air scouring air at filter air scour header shall not exceed 260 degrees F.

F. pH ranges of filter influent and backwash water are expected to be approximately 6 to 7.5 pH units.

2.03 FILTER AIR SCOUR HEADER AND RISER ASSEMBLIES AND ACCESSORIES:

A. The underdrain supplier shall be responsible for providing all piping and miscellaneous hardware such as fasteners required within each filter cell to achieve air scour capability. Piping with flanged connections shall be provided by the contractor to the inner edge of each filter cell.

B. Design each filter with air scour piping to provide uniform distribution of air during backwash.

1. Each assembly shall include air scour header and risers as shown on Drawings.
2. Materials of Construction: Headers and risers shall be Schedule 10 minimum, Type 304 stainless steel pipe.

C. Provide sleeves, couplings, and miscellaneous hardware to connect drop legs to flume block, as applicable.

D. Provide pipe supports/restraints, concrete anchors, and miscellaneous hardware (for example, fasteners) for header and drop pipes. Metallic components shall be Type 304 stainless steel.

E. Equipment Flanges: Comply with ASME B16.1, Class 125 or ASME B16.5, Class 150, unless otherwise indicated.

2.04 ANCHOR BOLTS

A. Anchor Bolts: Type 316 stainless steel, sized by equipment manufacturer, and as specified in Section 05 50 00, Metal Fabrications.

B. Threaded assemblies shall be chemically treated or lubricated prior to assembling to prevent galling.

C. Concrete Anchors: Adhesive type.

D. Anchoring Adhesives:

1. Hybrid Adhesive:
   a. Two components, insensitive to moisture, designed to be installed in adverse freeze/thaw environment.
   b. Cure temperature, pot life, and workability compatible for intended use and anticipated environmental conditions.
   c. Manufacturer and Product: Hilti, Inc., Tulsa, OK; HIT Doweling Anchor System (HIT HY-200R).

E. Wedge or expansion anchors shall not be acceptable.

2.05 GROUT

A. A minimum of two 1/2-inch deep by 8-inch wide grout seal strips down both sides shall be required. Thickness varies with conditions with grout surface to be highest point on the filter floor. To be finished with 1/8-inch end to end and 1/16-inch side to side. Grout and seal manufacturer as recommended by underdrain manufacturer.

2.06 SPECIAL TOOLS

A. Provide special tools and lubricants needed to install underdrain system.

2.07 FABRICATION

A. Metals below top of filter box wall shall be Type 304 stainless steel as appropriate. Hot dipped galvanized steel shall not be acceptable.

B. Metallic components shall be premanufactured (for example, concrete anchors) or shop fabricated (for example, air scour header assemblies) components. Field fabrication, bending, cutting, or welding shall not be acceptable.

C. After fabrication, pickle and passivate stainless steel assemblies and parts according to ASTM A380.

2.08 SOURCE QUALITY CONTROL

A. Factory Testing:

1. Notify Engineer at least 2 weeks prior to testing so Engineer or Owner can, at their option, witness testing.
2. Provide written report summarizing factory test results signed and sealed by a professional engineer.

B. Prior to shipment from factory test one full length lateral for head loss and uniform distribution of air and water. Test lateral in a test cell capable of isolating and physically measuring flow rates at 24-inch intervals. Head loss shall also be measured at 24-inch intervals. Acceptable results of the head loss and dispersion tests are as specified.

PART 3 EXECUTION

3.01 EXAMINATION

A. Prior to commencement of installation of underdrain system, manufacturer's representative shall inspect filter preparation work and provide written confirmation that filters are satisfactorily prepared for the installation of air scour and underdrain system. Contractor is responsible to provide a smooth level surface as required by the manufacturer after demolition.

3.02 INSTALLATION

A. General:

1. Install in accordance with manufacturer's instructions, recommendations, and interface requirements with surrounding structures, including requirements for grouting keys and pockets, dowels, support ledges and piers, anchorage.
2. Install adhesive anchors in accordance with adhesive manufacturer's recommendation.

B. Cleaning:

1. Remove debris and sand from filter gullets and power wash inside of gullet.
2. Take precautions recommended by underdrain manufacturer or specified herein to ensure filter underdrain system and associated piping and conduits are completely clean and free of debris, dirt, or other foreign materials which could clog underdrain system or interfere with flow.
3. Flush backwash air piping and recessed flume.
4. Remove loose debris and dirt within filter cell and flume by brooming down and vacuuming.
5. Engineer and filter underdrain manufacturer's representative shall approve cleaning before Contractor may begin placement of filter media.

C. Protection:

1. As installation progresses, protect partially completed portions of the Work to maintain cleanliness of underdrain system.
2. Maintain protection until media is installed.

D. Stainless Steel Lateral Filter Underdrain System:

1. Laterals with warped surfaces or uneven orifices, or laterals that are cracked, chipped, spalled, or otherwise damaged will not be used.
2. Set in place and anchor to position in a true and level plane within tolerance specified by underdrain system manufacturer.
3. Continuously monitored levelness during placement.
    a. Level measurement and monitoring shall be by means acceptable to Engineer.
    b. Failure of filter underdrain section to meet required level tolerance shall require removal of failed sections and replacement with new sections to within level tolerances.
4. Lateral Feed Orifices:
    a. Install laterals over a reinforced flow adaptor feed box receiving flow along length of recessed flume.
    b. Size primary orifices onsite by dynamic hydraulic profiling utilizing a minimum of six flow measurement devices simultaneously measuring backwash flow in a series of tests.

E. Grout:

1. Place and cure grout as directed by grout and underdrain manufacturers.
2. Keep grout out of orifices and flow passages and prevent grout from being deposited where it could interfere with flow.

3.03 TESTS AND INSPECTIONS

A. Perform backwash and filtration tests on completed system following installation of underdrain system, curing of concrete and grout, and prior to placing filter media.

1. Test grout in accordance with Section 03 62 00, Nonshrink Grouting.

B. Perform tests in both filtration (downflow) and backwash (upflow) modes at specified rates to confirm hydraulic performance is in compliance with this Section.

C. Check for and correct leaks and nonuniform flow of backwash water and air, structural instability, or other defects.

D. During backwash test, visually observe for signs of dead spots or boils. Evidence of flow maldistribution such as a water “mound” or “boil” in filter will constitute a failed test.

E. If defects require correction, retest as necessary until results are acceptable to Engineer.

F. Test Report: State results of tests, procedures used, details of adjustments made to unit, and precautions to be taken to ensure proper and safe operation and maintenance of unit.

G. Filter underdrain system manufacturer's representative shall not furnish a Certificate of Proper Installation until representative is satisfied filter underdrain system has been properly installed and functionally tested and that detrimental affects of subsequent filter media placement have been remedied.

3.04 MANUFACTURER'S SERVICES

A. Manufacturer's Representative: Present at Site or classroom designated by Owner, for minimum person-days listed below, travel time excluded:

1. 20 person-days and five trips for inspection of two filters prior to installation of underdrain system, observe placement of filter media in each filter, installation assistance and inspection of eight filters, functional and performance testing and completion of Manufacturer's Certificate of Proper Installation, prestartup classroom or Site training, facility startup, and post-startup training of Owner's personnel. Training shall not commence until an accepted detailed lesson plan for each training activity has been reviewed by Owner.

B. See Section 01 43 33, Manufacturers' Field Services and Section 01 91 14, Equipment Testing and Facility Startup.

END OF SECTION

PART 4

DRAWINGS
(BOUND SEPARATELY)