

CONTRACT DOCUMENTS FOR
CONSTRUCTION OF

CHEMICAL SYSTEMS AND ACTUATOR IMPROVEMENTS

BID #913



PREPARED FOR THE

FAYETTE COUNTY WATER SYSTEM FAYETTE COUNTY, GEORGIA

SPECIFICATIONS
VOLUME 1 OF 2

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CH2MHILL®

Project No.
486753, 496783

AUGUST 2014

BID DOCUMENTS

FAYETTE COUNTY WATER SYSTEM

FAYETTE COUNTY, GEORGIA

**BIDDING REQUIREMENTS
AND
CONTRACT DOCUMENTS**

for the construction of the

CHEMICAL SYSTEMS AND ACTUATOR IMPROVEMENTS BID # 913

CH2M HILL
Atlanta, Georgia
August 2014

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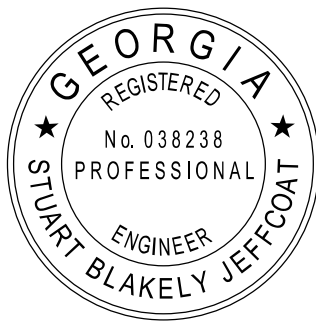
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**SECTION 00 01 07
SEALS PAGE**

**FAYETTE COUNTY WATER SYSTEM
FAYETTE COUNTY, GEORGIA
ACTUATOR AND LIME SYSTEM IMPROVEMENTS**

Front Ends and General Requirements
Stuart Jeffcoat



Process Mechanical
Kristina Yanosek



Architectural
Tim Dodge



Electrical
Kirsten Horton



I&C
PY Keskar



Civil
Jose Ramos



SECTION 00 01 07
SEALS PAGE

FAYETTE COUNTY WATER SYSTEM
FAYETTE COUNTY, GEORGIA
ACTUATOR AND LIME SYSTEM IMPROVEMENTS

Structural
Mark Chrzanowski



TABLE OF CONTENTS

Pages

PART 1—PROCUREMENT REQUIREMENTS

| | | |
|-------------|---|-------|
| 00 11 13 | Invitation to Bid | 1- 1 |
| 00 11 56.01 | Bidders Qualification Form | 1- 15 |
| 00 21 13 | Instruction to Bidders..... | 1- 11 |
| 00 41 13 | Bid Form | 1- 8 |
| 00 43 13 | Bid Bond | 1- 2 |
| 00 45 54 | Affidavit of Noncollusion | 1- 1 |
| 00 45 57 | Security and Immigration Compliance Act | 1- 1 |
| | Contractor Affidavit and Agreement | |
| | Subcontractor Affidavit | |

PART 2—CONTRACTING REQUIREMENTS

CONTRACTING FORMS

| | | |
|----------|----------------|------|
| 00 52 13 | Agreement..... | 1- 8 |
|----------|----------------|------|

PROJECT FORMS

| | | |
|-------------|----------------------------|------|
| 00 61 13.13 | Performance Bond Form..... | 1- 4 |
| 00 61 13.16 | Payment Bond Form | 1- 4 |

CONDITIONS OF THE CONTRACT

| | | |
|----------|-------------------------------|-------|
| 00 72 00 | General Conditions | 1- 40 |
| 00 73 00 | Supplementary Conditions..... | 1- 18 |

PART 3—SPECIFICATIONS

DIVISION 1—GENERAL REQUIREMENTS

| | | |
|----------|---|------|
| 01 11 00 | Summary of Work..... | 1- 1 |
| 01 26 00 | Contract Modification Procedures | 1- 6 |
| 01 29 00 | Payment Procedures..... | 1- 4 |
| 01 31 13 | Project Coordination | 1- 6 |
| 01 31 19 | Project Meetings | 1- 3 |
| 01 32 00 | Construction Progress Documentation | 1- 6 |
| 01 33 00 | Submittal Procedures | 1- 8 |
| | Supplement 1, Form: Transmittal of Contractor's Submittal | |
| 01 43 33 | Manufacturers' Field Services | 1- 4 |
| | Supplement 1, Form: Manufacturer's Certificate of Proper Installation | |
| | Supplement 2, Form: Manufacturer's Certificate of Compliance | |

| | | <u>Pages</u> |
|----------|--|--------------|
| 01 45 33 | Special Inspection, Observation, and Testing..... | 1- 6 |
| | Supplement 1, Contractor's Statement of Responsibility | |
| | Supplement 2, Component Manufacturer's Seismic Certificate of Compliance | |
| 01 50 00 | Temporary Facilities and Controls | 1- 5 |
| 01 57 13 | Temporary Erosion and Sediment Control | 1- 8 |
| 01 77 00 | Closeout Procedures | 1- 3 |
| 01 78 23 | Operation and Maintenance Data | 1- 5 |
| 01 88 15 | Anchorage and Bracing | 1- 6 |
| 01 91 14 | Equipment Testing and Facility Startup | 1- 5 |
| | Supplement 1, Unit Process Startup Form | |
| | Supplement 2, Facility Performance Demonstration/Certification Form | |

DIVISION 2—EXISTING CONDITIONS

| | | |
|----------|------------------|------|
| 02 41 00 | Demolition | 1- 7 |
|----------|------------------|------|

DIVISION 3—CONCRETE

| | | |
|----------|---|-------|
| 03 10 00 | Concrete Forming and Accessories | 1- 4 |
| 03 15 00 | Concrete Joints and Accessories..... | 1- 5 |
| 03 21 00 | Reinforcing Steel | 1- 4 |
| 03 30 00 | Cast-In-Place Concrete | 1- 23 |
| | Supplement 1, Concrete Mix Design, Class 5000F3S1P2C2 | |
| | Supplement 2, Concrete Mix Design, Class 4500F3S1P1C2 | |
| 03 39 00 | Concrete Curing | 1- 3 |
| 03 62 00 | Nonshrink Grouting | 1- 4 |

DIVISION 4—MASONRY (NOT USED)

DIVISION 5—METALS

| | | |
|----------|--------------------------|-------|
| 05 50 00 | Metal Fabrications | 1- 12 |
| 05 52 16 | Aluminum Railings..... | 1- 8 |

DIVISION 6—WOOD, PLASTICS, AND COMPOSITES

| | | |
|----------|--------------------------------------|------|
| 06 82 00 | Glass-Fiber-Reinforced Plastic | 1- 6 |
|----------|--------------------------------------|------|

DIVISIONS 7 THROUGH 8 (NOT USED)

DIVISION 9—FINISHES

| | | |
|----------|--|-------|
| 09 90 04 | Painting (Condensed)..... | 1- 14 |
| | Supplement 1, Paint System Data Sheet (PSDS) | |
| | Supplement 2, Product Data Sheet (PDS) | |
| 09 96 35 | Chemical-Resistant Coatings | 1- 5 |

DIVISION 10—SPECIALTIES

| | | |
|----------|-----------------------------|------|
| 10 14 00 | Signage..... | 1- 4 |
| | Supplement 1, Sign Schedule | |

DIVISIONS 11 THROUGH 12 (NOT USED)**DIVISION 13—SPECIAL CONSTRUCTION**

| | | |
|----------|-----------------------------|-------|
| 13 34 23 | Fabricated Structures | 1- 13 |
|----------|-----------------------------|-------|

DIVISIONS 14 THROUGH 25 (NOT USED)**DIVISION 26—ELECTRICAL**

| | | |
|----------|------------------|-------|
| 26 05 01 | Electrical | 1- 34 |
|----------|------------------|-------|

DIVISIONS 27 THROUGH 30 (NOT USED)**DIVISION 31—EARTHWORK**

| | | |
|-------------|----------------------------|------|
| 31 23 13 | Subgrade Preparation | 1- 3 |
| 31 23 16 | Excavation | 1- 3 |
| 31 23 23 | Fill and Backfill | 1- 7 |
| 31 23 23.15 | Trench Backfill | 1- 6 |

DIVISION 32—EXTERIOR IMPROVEMENTS (NOT USED)**DIVISION 33—UTILITIES**

| | | |
|-------------|---|------|
| 33 05 16.13 | Precast Concrete Utility Structure | 1- 5 |
| 33 13 00 | Disinfection of Water Utility Distribution Facilities | 1- 4 |

DIVISIONS 34 THROUGH 39 (NOT USED)

DIVISION 40—PROCESS INTEGRATION

| | | |
|-------------|--|-------|
| 40 05 15 | Piping Support Systems | 1- 10 |
| | Supplement 1, Table 1: Nonchemical Areas | |
| | Supplement 2, Table 2: Chemical Areas | |
| 40 05 33 | Pipe Heat Tracing | 1- 5 |
| 40 27 00 | Process Piping—General | 1- 18 |
| | Supplement 1, Piping Schedule Legend | |
| | Supplement 2, Piping Schedule | |
| 40 27 00.01 | Cement-Mortar-Lined Ductile Iron Pipe and Fittings | 1- 3 |
| 40 27 00.03 | Carbon Steel Pipe and Fittings..... | 1- 4 |
| 40 27 00.10 | Polyvinyl Chloride (PVC) Pipe and Fittings | 1- 2 |
| 40 27 00.13 | Copper and Copper Alloy Pipe, Tubing, and Fittings | 1- 1 |
| 40 27 01 | Process Piping Specialties | 1- 9 |
| 40 27 02 | Process Valves and Operators..... | 1- 15 |
| | Supplement 1, Electric Actuated Valve Schedule | |
| | Supplement 2, Self-Regulated Valve Schedule | |
| 40 42 13 | Process Piping Insulation..... | 1- 7 |
| | Supplement 1, Service and Insulation Thickness Table | |
| 40 80 01 | Process Piping Leakage Testing | 1- 3 |
| 40 90 01 | Instrumentation and Control for Process Systems..... | 1- 43 |
| | Supplement 1, Component Specifications | |
| | Supplement 2, Instrument and Control Panel List | |
| | Supplement 3, Loop Specifications | |
| | Supplement 4, PLC Input and Output List | |
| | Supplement 5, Instrument Calibration Sheet | |
| | Supplement 6, I&C Valve Adjustment Sheet | |
| | Supplement 7, Performance Acceptance Test Sheet | |
| | Supplement 8, As-Built Fiber Optic Cable Installation Form | |
| 40 99 90 | Package Control Systems..... | 1- 17 |

DIVISIONS 41 THROUGH 42 (NOT USED)**DIVISION 43—PROCESS GAS AND LIQUID HANDLING, PURIFICATION, AND STORAGE EQUIPMENT**

| | | |
|----------|---|-------|
| 43 40 01 | Polyethylene Storage Tank | 1- 10 |
| | Supplement 1, Tank Data Sheet T-682-1 | |
| | Supplement 2, Tank Data Sheet T-682-2 | |
| 43 40 10 | Lime Slurry Chemical Storage and Feed System | 1- 15 |
| | Supplement 1, Burnett Lime Company, Inc., proposal document | |

DIVISION 44—POLLUTION CONTROL EQUIPMENT

| | | |
|-------------|--|------|
| 44 44 13.01 | Chemical Metering Pumps..... | 1- 6 |
| | Supplement 1, Chemical Metering Pump Data Sheet-Sodium | |
| | Permanganate Feed Pump 1 and 2 | |

DIVISIONS 45 THROUGH 49 (NOT USED)

PART 4—DRAWINGS (BOUND SEPARATELY)

END OF SECTION

PART 1

PROCUREMENT REQUIREMENTS

INVITATION TO BID

Sealed Bids for construction of Chemical Systems and Actuator Improvements Bid #913, 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 **12th** day of **September, 2014**. Any Bids received after the specified time will not be considered.

Bids will then be publicly opened and read.

The Project contemplated consists of a lime storage and feed system at the South Fayette Water Treatment Plant and the Crosstown Water Treatment Plant, and a sodium permanganate storage and feed system at the Crosstown Water Treatment Plant. The Work also includes replacement of three hydraulic valve actuators at the Lake Horton Raw Water Pump Station with new electric actuators.

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 Stuart Jeffcoat 678-530-4182.

Attendance at a prebid conference 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 13th day of August 2014.

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
 Address: _____
 Telephone Number: _____
 Contact Person: _____

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 | | | | | |
| 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 CAPITALCurrent 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 in the number and for the deposit sum, if any, stated in the Invitation to Bid may be obtained from the Issuing Office.

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. Full-size Drawings may be obtained from Engineer at cost of reproduction and handling, plus postage for mailing (if mailing is requested). Drawings will only be made available to firms listed as having complete sets of Bidding Documents. No return of full-size Drawings is required, and no refund will be made.

2.4. 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 **August 21, 2014** 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. Engineer will transmit 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 Engineer in writing. Interpretations or clarifications considered necessary by Engineer in response to such questions will be issued by Addenda mailed or delivered to all parties recorded by the office issuing documents as having received the Bidding Documents. 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, cash or 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. WAGE RATES

12.1. The Work under these Bidding Documents is to be paid for by public funds; therefore, minimum prevailing wage rates published by are applicable. Refer to Paragraph 6.09.D of the Supplementary Conditions for more information.

13. PREPARATION OF BID

13.1. 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.

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

13.3. 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.

13.4. 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.

13.5. 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.

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

13.7. 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.

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

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

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

13.11. 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.

14. BASIS OF BID; COMPARISON OF BIDS

14.1. Lump Sum:

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

14.2. Unit Price:

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

14.2.2. 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.

14.2.3. 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.

14.3. Allowances:

14.3.1. Cash Allowance:

14.3.1.1. 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.

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

15. SUBMISSION OF BID

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

15.1.1. Bidder's Experience.

15.1.2. Bidder's Qualification.

15.1.3. List of Project References.

15.1.4. Certificate of Bidder Regarding Equal Opportunity.

15.1.5. 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.

15.1.6. Contractor's License No.

15.1.7. Statement of Noncollusion.

15.2. 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."

16. MODIFICATION AND WITHDRAWAL OF BID

16.1. 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.

16.2. If within 24 hours after Bids are opened any Bidder files a duly signed written notice with Owner and promptly thereafter demonstrates to the reasonable satisfaction of Owner that there was a material and substantial mistake in the preparation of its Bid, that Bidder may withdraw its Bid, and the Bid security will be returned. Thereafter, if the Work is rebid, that Bidder will be disqualified from further bidding on the Work.

17. OPENING OF BIDS

17.1. 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.

18. BIDS TO REMAIN SUBJECT TO ACCEPTANCE

18.1. 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.

19. EVALUATION OF BIDS AND AWARD OF CONTRACT

19.1. 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.

19.2. 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.

19.3. 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.

19.4. 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.

19.5. 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.

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

20. CONTRACT SECURITY AND INSURANCE

20.1. 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.

21. SIGNING OF AGREEMENT

21.1. 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:

21.1.1. 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.

21.1.2. 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.

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

21.2.1. Register with Commissioner and pay fee.

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

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

21.3. 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.

22. RETAINAGE

22.1. 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

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.

| Specification Section No. | Preselected Equipment Name and Manufacturer | Negotiated Price |
|----------------------------------|--|-------------------------|
| 43 40 10 | Lime Slurry Chemical Storage and Feed System | \$507,850.00 |

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 | |
|------------------------------|----------------|
| M/R Systems | Norcross, GA |
| 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 | \$20,000.00 |
| Total Amount For Allowances | | \$20,000.00 |

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)

Bidder's Name and Corporate Seal

_____(Seal)

Surety's Name and Corporate Seal

By: _____
Signature and Title

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

Attest: _____
Signature and Title

Attest: _____
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 contract. 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 contract 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 _____, ____, 201__ 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 _____, 201__.

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 _____, ____, 201__ 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 _____, 201__.

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 at both the Crosstown and South Fayette Water Treatment Plants and actuator improvements at the Lake Horton Raw Water Pump Station.

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: Liquid lime storage and feed system additions at both the Crosstown and South Fayette Water Treatment Plants; Sodium Permanganate storage and feed system addition at the South Fayette Water Treatment Plant; Actuator improvements at the Lake Horton Raw Water Pump Station; electrical system improvements to support new loads; computer-based controls and associated improvements; and erosion control and area restoration to include pavement and sidewalk replacement, as required and detailed.

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. 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: _____

Title: _____

[CORPORATE SEAL]

By: _____

Attest: _____

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):

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**SURETY**

Company:

Signature: _____ (Seal)
Name and Title

Surety's Name and Corporate Seal

By: _____
Signature and Title

(Attach Power of Attorney)

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

Attest: _____
Signature and Title

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CONTRACTOR AS PRINCIPAL

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):

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**SURETY**

Company:

Signature: _____ (Seal)
Name and Title

Surety's Name and Corporate Seal

By: _____
Signature and Title

(Attach Power of Attorney)

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

Attest: _____
Signature and Title

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CONTRACTOR AS PRINCIPAL

SURETY

Company:

Signature: _____ (Seal)
Name and Title

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

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Endorsed by



CONSTRUCTION SPECIFICATIONS INSTITUTE

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

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STANDARD GENERAL CONDITIONS OF THE CONSTRUCTION CONTRACT

TABLE OF CONTENTS

| | Page |
|---|-------------|
| ARTICLE 1 – DEFINITIONS AND TERMINOLOGY | 1 |
| 1.01 <i>Defined Terms</i> | 1 |
| 1.02 <i>Terminology</i> | 3 |
| ARTICLE 2 – PRELIMINARY MATTERS | 4 |
| 2.01 <i>Delivery of Bonds and Evidence of Insurance</i> | 4 |
| 2.02 <i>Copies of Documents</i> | 4 |
| 2.03 <i>Commencement of Contract Times; Notice to Proceed</i> | 4 |
| 2.04 <i>Starting the Work</i> | 4 |
| 2.05 <i>Before Starting Construction</i> | 4 |
| 2.06 <i>Preconstruction Conference; Designation of Authorized Representatives</i> | 5 |
| 2.07 <i>Initial Acceptance of Schedules</i> | 5 |
| ARTICLE 3 – CONTRACT DOCUMENTS: INTENT, AMENDING, REUSE..... | 5 |
| 3.01 <i>Intent</i> | 5 |
| 3.02 <i>Reference Standards</i> | 5 |
| 3.03 <i>Reporting and Resolving Discrepancies</i> | 6 |
| 3.04 <i>Amending and Supplementing Contract Documents</i> | 6 |
| 3.05 <i>Reuse of Documents</i> | 6 |
| 3.06 <i>Electronic Data</i> | 7 |
| ARTICLE 4 – AVAILABILITY OF LANDS; SUBSURFACE AND PHYSICAL CONDITIONS; HAZARDOUS ENVIRONMENTAL CONDITIONS; REFERENCE POINTS..... | 7 |
| 4.01 <i>Availability of Lands</i> | 7 |
| 4.02 <i>Subsurface and Physical Conditions</i> | 7 |
| 4.03 <i>Differing Subsurface or Physical Conditions</i> | 7 |
| 4.04 <i>Underground Facilities</i> | 8 |
| 4.05 <i>Reference Points</i> | 9 |
| 4.06 <i>Hazardous Environmental Condition at Site</i> | 9 |
| ARTICLE 5 – BONDS AND INSURANCE | 10 |
| 5.01 <i>Performance, Payment, and Other Bonds</i> | 10 |
| 5.02 <i>Licensed Sureties and Insurers</i> | 11 |
| 5.03 <i>Certificates of Insurance</i> | 11 |
| 5.04 <i>Contractor's Insurance</i> | 11 |
| 5.05 <i>Owner's Liability Insurance</i> | 12 |
| 5.06 <i>Property Insurance</i> | 12 |
| 5.07 <i>Waiver of Rights</i> | 13 |
| 5.08 <i>Receipt and Application of Insurance Proceeds</i> | 13 |
| 5.09 <i>Acceptance of Bonds and Insurance; Option to Replace</i> | 14 |
| 5.10 <i>Partial Utilization, Acknowledgment of Property Insurer</i> | 14 |
| ARTICLE 6 – CONTRACTOR'S RESPONSIBILITIES | 14 |
| 6.01 <i>Supervision and Superintendence</i> | 14 |
| 6.02 <i>Labor; Working Hours</i> | 14 |
| 6.03 <i>Services, Materials, and Equipment</i> | 14 |

| | | |
|---|--|----|
| 6.04 | <i>Progress Schedule</i> | 15 |
| 6.05 | <i>Substitutes and “Or-Equals”</i> | 15 |
| 6.06 | <i>Concerning Subcontractors, Suppliers, and Others</i> | 16 |
| 6.07 | <i>Patent Fees and Royalties</i> | 17 |
| 6.08 | <i>Permits</i> | 18 |
| 6.09 | <i>Laws and Regulations</i> | 18 |
| 6.10 | <i>Taxes</i> | 18 |
| 6.11 | <i>Use of Site and Other Areas</i> | 18 |
| 6.12 | <i>Record Documents</i> | 19 |
| 6.13 | <i>Safety and Protection</i> | 19 |
| 6.14 | <i>Safety Representative</i> | 20 |
| 6.15 | <i>Hazard Communication Programs</i> | 20 |
| 6.16 | <i>Emergencies</i> | 20 |
| 6.17 | <i>Shop Drawings and Samples</i> | 20 |
| 6.18 | <i>Continuing the Work</i> | 21 |
| 6.19 | <i>Contractor’s General Warranty and Guarantee</i> | 21 |
| 6.20 | <i>Indemnification</i> | 22 |
| 6.21 | <i>Delegation of Professional Design Services</i> | 22 |
| ARTICLE 7 – OTHER WORK AT THE SITE | | 22 |
| 7.01 | <i>Related Work at Site</i> | 22 |
| 7.02 | <i>Coordination</i> | 23 |
| 7.03 | <i>Legal Relationships</i> | 23 |
| ARTICLE 8 – OWNER’S RESPONSIBILITIES | | 23 |
| 8.01 | <i>Communications to Contractor</i> | 23 |
| 8.02 | <i>Replacement of Engineer</i> | 23 |
| 8.03 | <i>Furnish Data</i> | 23 |
| 8.04 | <i>Pay When Due</i> | 23 |
| 8.05 | <i>Lands and Easements; Reports and Tests</i> | 23 |
| 8.06 | <i>Insurance</i> | 24 |
| 8.07 | <i>Change Orders</i> | 24 |
| 8.08 | <i>Inspections, Tests, and Approvals</i> | 24 |
| 8.09 | <i>Limitations on Owner’s Responsibilities</i> | 24 |
| 8.10 | <i>Undisclosed Hazardous Environmental Condition</i> | 24 |
| 8.11 | <i>Evidence of Financial Arrangements</i> | 24 |
| 8.12 | <i>Compliance with Safety Program</i> | 24 |
| ARTICLE 9 – ENGINEER’S STATUS DURING CONSTRUCTION | | 24 |
| 9.01 | <i>Owner’s Representative</i> | 24 |
| 9.02 | <i>Visits to Site</i> | 24 |
| 9.03 | <i>Project Representative</i> | 24 |
| 9.04 | <i>Authorized Variations in Work</i> | 25 |
| 9.05 | <i>Rejecting Defective Work</i> | 25 |
| 9.06 | <i>Shop Drawings, Change Orders and Payments</i> | 25 |
| 9.07 | <i>Determinations for Unit Price Work</i> | 25 |
| 9.08 | <i>Decisions on Requirements of Contract Documents and Acceptability of Work</i> | 25 |
| 9.09 | <i>Limitations on Engineer’s Authority and Responsibilities</i> | 25 |
| 9.10 | <i>Compliance with Safety Program</i> | 26 |
| ARTICLE 10 – CHANGES IN THE WORK; CLAIMS | | 26 |
| 10.01 | <i>Authorized Changes in the Work</i> | 26 |
| 10.02 | <i>Unauthorized Changes in the Work</i> | 26 |
| 10.03 | <i>Execution of Change Orders</i> | 26 |
| 10.04 | <i>Notification to Surety</i> | 26 |
| 10.05 | <i>Claims</i> | 27 |

| | |
|---|----|
| ARTICLE 11 – COST OF THE WORK; ALLOWANCES; UNIT PRICE WORK | 27 |
| 11.01 <i>Cost of the Work</i> | 27 |
| 11.02 <i>Allowances</i> | 29 |
| 11.03 <i>Unit Price Work</i> | 29 |
| ARTICLE 12 – CHANGE OF CONTRACT PRICE; CHANGE OF CONTRACT TIMES | 30 |
| 12.01 <i>Change of Contract Price</i> | 30 |
| 12.02 <i>Change of Contract Times</i> | 30 |
| 12.03 <i>Delays</i> | 31 |
| ARTICLE 13 – TESTS AND INSPECTIONS; CORRECTION, REMOVAL OR ACCEPTANCE OF DEFECTIVE WORK.. | 31 |
| 13.01 <i>Notice of Defects</i> | 31 |
| 13.02 <i>Access to Work</i> | 31 |
| 13.03 <i>Tests and Inspections</i> | 31 |
| 13.04 <i>Uncovering Work</i> | 32 |
| 13.05 <i>Owner May Stop the Work</i> | 32 |
| 13.06 <i>Correction or Removal of Defective Work</i> | 32 |
| 13.07 <i>Correction Period</i> | 32 |
| 13.08 <i>Acceptance of Defective Work</i> | 33 |
| 13.09 <i>Owner May Correct Defective Work</i> | 33 |
| ARTICLE 14 – PAYMENTS TO CONTRACTOR AND COMPLETION | 34 |
| 14.01 <i>Schedule of Values</i> | 34 |
| 14.02 <i>Progress Payments</i> | 34 |
| 14.03 <i>Contractor's Warranty of Title</i> | 35 |
| 14.04 <i>Substantial Completion</i> | 36 |
| 14.05 <i>Partial Utilization</i> | 36 |
| 14.06 <i>Final Inspection</i> | 36 |
| 14.07 <i>Final Payment</i> | 37 |
| 14.08 <i>Final Completion Delayed</i> | 37 |
| 14.09 <i>Waiver of Claims</i> | 38 |
| ARTICLE 15 – SUSPENSION OF WORK AND TERMINATION | 38 |
| 15.01 <i>Owner May Suspend Work</i> | 38 |
| 15.02 <i>Owner May Terminate for Cause</i> | 38 |
| 15.03 <i>Owner May Terminate For Convenience</i> | 39 |
| 15.04 <i>Contractor May Stop Work or Terminate</i> | 39 |
| ARTICLE 16 – DISPUTE RESOLUTION | 39 |
| 16.01 <i>Methods and Procedures</i> | 39 |
| ARTICLE 17 – MISCELLANEOUS | 40 |
| 17.01 <i>Giving Notice</i> | 40 |
| 17.02 <i>Computation of Times</i> | 40 |
| 17.03 <i>Cumulative Remedies</i> | 40 |
| 17.04 <i>Survival of Obligations</i> | 40 |
| 17.05 <i>Controlling Law</i> | 40 |
| 17.06 <i>Headings</i> | 40 |

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, expeditors, timekeepers, clerks, and other personnel employed by Contractor, whether at the Site or in

Contractor's principal or branch office for general administration of the Work and not specifically included in the agreed upon schedule of job classifications referred to in Paragraph 11.01.A.1 or specifically covered by Paragraph 11.01.A.4, all of which are to be considered administrative costs covered by the Contractor's fee.

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

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

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

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

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-2.02. 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 September 30, 1997 prepared for South Fayette WTP by Piedmont Geotechnical Associates and supplemental design memo by CH2M HILL dated March 2014.

4.02.C.2. 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.D.2. South Fayette WTP Drawings: As-Builts Jan. 2002 South Fayette County Water Treatment Plant by Mallet V. Associates.

4.02.D.3. Lake Horton RWPS Drawings: 4-7-95 Horton Creek Reservoir to Stars Mill Raw Water Pumping Facilities for Fayette County Water System by Mallet V. Associates; and 9-18-01 As-Builts Horton Creek Reservoir Additional Raw Water Pumping Facilities 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-5.04. 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 | <u>\$5,000,000</u> |
|----------------------|--------------------|

| | |
|--------------------|--------------------|
| 2) Each Occurrence | <u>\$5,000,000</u> |
|--------------------|--------------------|

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 | <u>\$1,000,000</u> |
|-------------|--------------------|

| | |
|---------------|---------------------|
| Each Accident | <u>\$ 1,000,000</u> |
|---------------|---------------------|

5.04.C.3.b. Property Damage:

| | |
|---------------|--------------------|
| Each Accident | <u>\$1,000,000</u> |
|---------------|--------------------|

| | |
|--------------------------------------|--------------------|
| 5.04.C.3.c. Combined Single Limit of | <u>\$1,000,000</u> |
|--------------------------------------|--------------------|

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 | <u>\$1,000,000</u> |
|---------------|--------------------|

| | |
|------------------|--------------------|
| Annual Aggregate | <u>\$5,000,000</u> |
|------------------|--------------------|

5.04.C.4.b. Property Damage:

| | |
|---------------|--------------------|
| Each Accident | <u>\$1,000,000</u> |
|---------------|--------------------|

| | |
|------------------|--------------------|
| Annual Aggregate | <u>\$5,000,000</u> |
|------------------|--------------------|

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 a lime storage and feed system at the South Fayette Water Treatment Plant and the Crosstown Water Treatment Plant, as well as the associated demolition of the existing lime storage and feed systems at both plants. The Work also includes replacement of three hydraulic valve actuators at the Lake Horton Raw Water Pump Station with new electric actuators and the addition of a new sodium permanganate storage and feed system at the Crosstown Water Treatment Plant.

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:

| <u>Specification Section</u> | <u>Specific Product</u> |
|------------------------------|-------------------------------------|
| 43 40 10 | Lime Slurry Storage and Feed 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.

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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.
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.

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. Contractor shall begin and complete all improvements at the Crosstown WTP prior to initiating any Work at the South Fayette WTP or at the Lake Horton Raw Water Pump Station. Contractor must be substantial complete at one Site before commencing any construction Work at either of the two Sites associated with the Work.
- F. Modifications at the Crosstown Water Treatment Plant:
 - 1. Demolition of the existing lime systems will not take place until the new liquid lime system is installed and successfully operated for a 30 day period.
 - 2. Any shutdown of the plant required to construct the Work must be less than 8 hours in duration, unless otherwise specified or approved.
- G. Modifications at the South Fayette Water Treatment Plant:
 - 1. Work at Crosstown Water Treatment Plant shall be substantially complete prior to commencing Work at the South Fayette WTP.
 - 2. Existing lime system at South Fayette Water Treatment Plant to remain operational and cannot be demolished until the new liquid lime system is approved and successfully operated for a 30 day period.
- H. Modifications at the Lake Horton Raw Water Pump Station: The demolition of the existing actuators and oil accumulator system and the installation of the new electric actuated valves shall be complete prior to June 1, 2015.

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 Finished Water Pipeline.
 - 5) 20-inch finished water line.
 - b. South Fayette WTP:
 - 1) Chemical Building Raw Water Pipeline.
 - 2) Post Flash Mix Vault.
 - c. Lake Horton RWPS: Raw Water Pumps 1 and 2.
 - 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

| | | | |
|---|--|---------------------------------|--|
|  <div style="display: inline-block; vertical-align: middle; margin-left: 10px;"> TRANSMITTAL OF CONTRACTOR'S SUBMITTAL (ATTACH TO EACH SUBMITTAL) </div> | | | |
| DATE: _____ | | | |
| TO: _____ _____ _____ _____ _____ FROM: _____ <div style="text-align: center; margin-top: 10px;">Contractor</div> _____ _____ _____ | Submittal No.: _____ <input type="checkbox"/> New Submittal <input type="checkbox"/> Resubmittal Project: _____ Project No.: _____ Specification Section No.: _____ (Cover only one section with each transmittal) Schedule Date of Submittal: _____ _____ | | |
| SUBMITTAL TYPE: | <input type="checkbox"/> Shop Drawing | <input type="checkbox"/> Sample | <input type="checkbox"/> Informational |
| | <input type="checkbox"/> Deferred | | |

The following items are hereby submitted:

| Number of Copies | Description of Item Submitted (Type, Size, Model Number, Etc.) | Spec. and Para. No. | Drawing or Brochure No. | Contains Variation to Contract | |
|---------------------|---|------------------------|----------------------------|--------------------------------------|-----|
| | | | | No | Yes |
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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. For the lime system, it will only be required to record the training provided at one of the treatment plant Sites.

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 supplement listed below, following "End of Section", is 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: _____ PRODUCT, MATERIAL, OR SERVICE
PROJECT NAME: _____ SUBMITTED: _____
PROJECT NO: _____

Comments: _____

I hereby certify that the above-referenced product, material, or service called for by the Contract for the named Project will be furnished in accordance with all applicable requirements. I further certify that the product, material, or service are of the quality specified and conform in all respects with the Contract requirements, and are in the quantity shown.

Date of Execution: _____, 20__

Manufacturer: _____

By Manufacturer's Authorized Representative: _____
(Authorized Signature)

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.
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 |
| Liquid Lime Storage | Lime Slurry Chemical Storage and Feed System | 1.5 |
| Sodium Permanganate Storage | Sodium Permanganate Chemical 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:

- 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 |
|---|--|
| Liquid Lime Storage- Peachtree City WTP | Flat-bottom, Ground-supported, Reinforced Nonsliding Base, Concrete Tank |
| Liquid Lime Storage- South Fayette County WTP | Flat-bottom, Ground-supported, Reinforced Nonsliding Base, Concrete Tank |
| Sodium Permanganate Storage | Sodium Permanganate Chemical Storage And Feed System |

- and I, (We) are responsible for construction of the following components:

| Facility | Component |
|-----------------------------|--|
| Liquid Lime Storage | Lime Slurry Chemical Storage and Feed System |
| Sodium Permanganate Storage | Sodium Permanganate Chemical Storage And Feed System |

- 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 which 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.

1.03 SYSTEM DESCRIPTION

- A. Erosion, Sediment, and Flood Control: Provide, maintain, and operate temporary facilities to control erosion and sediment releases, and to protect the Work and existing facilities from flooding during construction period.

- B. Soil erosion stabilization and sedimentation control consists of the following elements:
 - 1. Construction and maintenance of permanent and temporary storm drainage piping and channel systems, as necessary.
 - 2. Construction of temporary erosion control facilities such as silt fences and check dams.
 - 3. 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 version, 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. Drainage and 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. Type-C silt fence in accordance with the “Manual for Erosion and Sediment Control in Georgia,” latest edition.

2.02 CLEARING LIMIT 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 Drainage and 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. Promptly repair or replace silt fence that becomes damaged.
- 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. Regrade unpaved earth drainage ditches as needed to maintain original grade and remove sediment buildup. If ditch becomes difficult to maintain, install additional erosion control devices such as check dams, temporary paving, or silt fences as directed by Engineer.
- E. Inspect, repair, and replace as necessary erosion control measures during the time period from start of construction to completion of construction.
- F. 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 CLEANING

- A. Dress sediment deposits remaining after fence has been removed to conform to existing grade. Prepare and seed graded area.

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).

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) $I_p = 1.0$, unless noted otherwise.
 - 2) I_p shall be taken as 1.5 if any of the following conditions apply:
 - a) Component is required to function for life-safety purposes after an earthquake, including fire protection sprinkler systems and egress stairways.
 - b) Component contains hazardous materials.
 - c) Component is in or attached to Risk Category IV structure and is needed for continued operation of facility or its failure could impair continued operation of facility.
 - 3) Refer to Section 01 45 33, Special Inspection, Observation and Testing, for list of designated components which I_p 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 nonbuilding structures for components with weights greater than or equal to 25 percent of effective seismic weight of overall structure.
2. Analyze local region of body of nonstructural component for load transfer of anchorage attachment if component $I_p = 1.5$.
3. Support drawings and calculations for electrical distribution components shall be provided if any of the following conditions apply:
 - a. I_p is equal to 1.5 and conduit diameter is greater than 2.5-inch trade size.

- b. I_p 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 nonvibration isolated mechanical equipment rated over 10 horsepower.

PART 3 EXECUTION

3.01 GENERAL

- A. Make attachments, bracing, and anchorage in such a manner that component lateral force is transferred to lateral force resisting system of structure through a complete load path.

- B. 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 liquid lime and sodium permanganate.
- 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. Structures of buildings 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. 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.
3. Sidewalks, curbs, gutters and street light bases shall be removed as indicated.
- 4.

C. Paving and Slabs:

1. Sawcut concrete and asphaltic concrete paving and slabs including aggregate base 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. 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. Traffic Control Signs: Where pedestrian and driver safety is endangered in the area of removal Work, use traffic barricades with flashing lights.
- D. Existing Work:
 - 1. Study 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.
- E. 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.

F. 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.

G. 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.

H. 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.

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 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. Nonsupporting forms, sides of beams, walls, columns, and similar parts of Work, may be removed after cumulatively curing at not less than 50 degrees F for 24 hours from time of concrete placement if:
1. Concrete is sufficiently hard so as not to sustain damage by form removal operations.
 2. Curing and protection operations are maintained.
- B. 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 nonpotentially reactive in accordance with Article Concrete Mix Design. Include documentation of test results per applicable standards.
- f. Admixtures: Manufacturer's catalog cut sheets and product data sheets for each admixture used in proposed mix designs.
2. Product Data: Specified ancillary materials.
3. Detailed plan for curing and protection of concrete placed and cured in cold weather. Details shall include, but not be limited to, the following:
 - a. Procedures for protecting subgrade from frost and accumulation of ice or snow on reinforcement, other metallic embeds, and forms prior to placement.
 - b. Procedures for measuring and recording temperatures of reinforcement and other embedded items prior to concrete placement.
 - c. Methods for temperature protection during placement.
 - d. Types of covering, insulation, housing, or heating to be provided.
 - e. Curing methods to be used during and following protection period.

- f. Use of strength accelerating admixtures.
- g. Methods for verification of in-place strength.
- h. Procedures for measuring and recording concrete temperatures.
- i. Procedures for preventing drying during dry, windy conditions.
- 4. Detailed plan for hot weather placements including curing and protection for concrete placed in ambient temperatures over 80 degrees F. Plan shall include, but not be limited to, the following:
 - a. Procedures for measuring, and recording temperatures of reinforcement and other embedded items prior to concrete placement.
 - b. Use of retarding admixture.
 - c. Methods for controlling temperature of reinforcement and other embedded items and concrete materials before and during placement.
 - d. Types of shading and wind protection to be provided.
 - e. Curing methods, including use of evaporation retardant.
 - f. Procedures for measuring and recording concrete temperatures.
 - g. Procedures for preventing drying during dry, windy conditions.
- 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- μ m (No. 200) sieve to 5 percent mass of total sample.
 - 2) Limit coal and lignite to 1.0 percent.
 - 3. Coarse Aggregate:
 - a. Natural gravels, combination of gravels and crushed gravels, crushed stone, or combination of these materials containing no more than 15 percent flat or elongated particles (long dimension more than five times the short dimension).
 - b. Limit deleterious substances in accordance with ASTM C33/C33M, Table 4 for specified class designation.
- C. Admixtures: Unless otherwise permitted, furnish from one manufacturer.
 - 1. Characteristics:
 - a. Compatible with other constituents in mix.
 - b. Contain at most, only trace amount chlorides in solution.
 - c. Furnish type of admixture as recommended by manufacturer for anticipated temperature ranges.
 - 2. Air-Entraining Admixture: ASTM C260/C260M.
 - 3. Water-Reducing Admixture: ASTM C494/C494M, Type A or Type D.
 - 4. Retarding Admixture: ASTM C 494/C 494M, Type B.
 - 5. Accelerating Admixture: ASTM C 494/C 494M, Type C.
 - 6. High-Range, Water-Reducing Admixture: ASTM C494/C494M, Type F or Type G.
 - 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 $(\text{Na}_2\text{O} + 0.658 \text{ K}_2\text{O})$: 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:

| Sieve Sizes | Combined Gradation Percentage Passing | | |
|-------------|---------------------------------------|------------|--------------|
| | 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 |

| Sieve Sizes | Combined Gradation Percentage Passing | | |
|-------------|---------------------------------------|------------|--------------|
| | 1-1/2" Max. | 1" Max. | 3/4" Max. |
| 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. When vertical expansion, contraction, or control joint spacing does not exceed 60 feet, intermediate construction joints are not required.
 - d. Uniformly space vertical construction joints within straight sections of walls and slabs, avoiding penetrations.
3. Consider beams, girders, brackets, column capitals, and haunches as part of floor or roof system and place monolithically with floor or roof system.
4. Should placement sequence result in cold joint located below finished water surface, install waterstop in joint.

H. Minimum Time between Adjacent Placements:

1. Construction 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, including elevated slab and diaphragm completion prior to backfill.
- C. Unless otherwise permitted, place backfill simultaneously on both sides of structure, where such fill is required, to prevent differential pressures.

3.08 FIELD QUALITY CONTROL

- A. General:
 - 1. Provide adequate facilities for safe storage and proper curing of concrete test specimens onsite for first 24 hours, and for additional time as may be required before transporting to test lab.
 - 2. Unless otherwise specified, sample concrete for testing for making test specimens, from point of delivery.
 - 3. When concrete is pumped, sample and test air content at point of delivery and at point of placement.
 - a. For Each Concrete Mixture: Provided results of air content tests for first load of the day are within specified limits, testing need only be performed at point of delivery for subsequent loads of that concrete mixture except that testing should be performed at point of placement every 4 hours.
 - 4. Evaluation will be in accordance with ACI 301 and Specifications.
 - 5. Test specimens shall be made, cured, and tested in accordance with ASTM C31/C31M and ASTM C39/C39M.
 - 6. Frequency of testing may be changed at discretion of Engineer.
 - 7. Pumped Concrete: Take concrete samples for slump, ASTM C143/C143M, and test specimens, ASTM C31/C31M and ASTM C39/C39M, 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: Liquid Lime Containment Structures.
3. Water for initial tightness test shall 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 as specified in Section 03 64 23, Crack Repair Epoxy Injection Grouting.

- b. Patch areas of damp spots previously recorded, and repeat water leakage test in its entirety until structure successfully passes test.

3.09 MANUFACTURER'S SERVICES

- A. Provide representative at Site in accordance with Section 01 43 33, Manufacturers' Field Services, for installation assistance, inspection, and certification of proper installation for concrete ingredients, mix design, mixing, and placement.
 - 1. Concrete Producer Representative:
 - a. Assist with concrete mix design, performance, placement, weather problems, and problems as may occur with concrete mix throughout Project, including instructions for redosing.
 - b. Establish control limits on concrete mix designs.
 - c. Provide equipment for control of concrete redosing for air entrainment or high-range, water-reducing admixture, superplasticizers, at Site to maintain proper slump and air content if needed.
 - 2. Admixture Manufacturer's Representative: Available for consultations as required to ensure proper installation and performance of specified products.
 - 3. Bonding Agent Manufacturer's Representative: Available for consultations as required to ensure proper installation and performance of specified products.

3.10 PROTECTION OF INSTALLED WORK

- A. After curing as specified in Section 03 39 00, Concrete Curing, and after applying final floor finish, cover slabs with plywood or particle board or plastic sheeting or other material to keep floor clean and protect it from material and damage as a result of other construction work.
- B. Repair areas damaged by construction, using specified repair materials and approved repair methods.

3.11 SCHEDULE OF CONCRETE FINISHES

- A. Form Tolerances: As specified in Section 03 10 00, Concrete Forming and Accessories.

B. 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.
al 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, nonyellowing, 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 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 | A992/992M |
| 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) ITW Ramset/Red Head, Addison, IL; Trubolt+ Wedge Anchor (ESR-2427).
 - 2) Hilti, Inc., Tulsa, OK; Kwik-Bolt-TZ (KB-TZ) Anchors (ESR-1917).
 - 3) Powers Fasteners, Brewster, NY; Power-Stud +SD2 or +SD1 Anchors (ESR-2502 and ESR-2818).
 - 4) Simpson Strong-Tie Co., Inc., Pleasanton, CA; Strong-Bolt Anchors (ESR-1771).
 - 5) Wej-It Corp., Tulsa, OK; ANKRtite CCAT Wedge Anchor (ESR-2777).
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 10 degrees to clear obstruction, notify Engineer for direction on how to proceed.
- F. Adhesive Anchors:
- 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.
 - 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.
 - For hollow-unit masonry, install screen tube in accordance with manufacturer's printed installation instructions.
 - Do not disturb anchor during recommended curing time.
 - Do not exceed maximum torque as specified in manufacturer's printed installation instructions.

3.04 ELECTROLYTIC PROTECTION

A. Stainless Steel:

- During handling and installation, take necessary precautions to prevent carbon impregnation of stainless steel members.
- After installation, visually inspect stainless steel surfaces for evidence of iron rust, oil, paint, and other forms of contamination.
- 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 | |

| Service Use and Location | Product | Remarks |
|--|----------------------------------|----------------|
| 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 05 52 16
ALUMINUM RAILINGS

PART 1 GENERAL

1.01 REFERENCES

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

1. Aluminum Association, Incorporated (AA): DAF45, Designation System for Aluminum Finishes.
2. American Concrete Institute (ACI) 318, Building Code Requirements for Structural Concrete.
3. American Iron and Steel Institute (AISI).
4. ASTM International (ASTM):
 - a. A193/A193M, Standard Specification for Alloy-Steel and Stainless Steel Bolting for High Temperature or High Pressure Service and Other Special Purpose Applications.
 - b. A194/A194M, Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both.
 - c. E894, Standard Test Method for Anchorage of Permanent Metal Railing Systems and Rails for Buildings.
 - d. E935, Standard Test Methods for Performance of Permanent Metal Railing Systems and Rails for Buildings.
 - e. E985, Standard Specification for Permanent Metal Railing Systems and Rails for Buildings.
5. International Code Council (ICC): International Building Code (IBC).
6. Occupational Safety and Health Act (OSHA): 29 CFR 1910, Code of Federal Regulations.

1.02 DEFINITIONS

- A. ICC Evaluation Services Report: ICC report on evaluation of manufactured concrete anchor systems.
- B. Railings: This term includes guardrail systems, handrail systems, platform railing systems, ramp-rail systems, and stair-rail systems. Railings may be comprised of a framework of vertical, horizontal, or inclined members, grillwork or panels, accessories, or combination thereof.
- C. Special Inspection: As defined by the ICC IBC.
- D. Toeboards: Vertical barrier at floor level usually erected on railings along exposed edges of floor or wall openings, platforms, or ramps to prevent miscellaneous items from falling through.

1.03 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.

1.04 SUBMITTALS

- A. Action Submittals:
 - 1. Shop Drawings:
 - a. Project-specific scaled plans and elevations of railings and detail drawings. Include railing profiles, sizes, connections, anchorage, size and type of fasteners, and accessories.
 - b. Manufacturer's literature and catalog data of railing and components.
 - c. Design Data: Calculations or test data using specified design performance loads and including the following:
 - 1) Bending stress in, and deflection of, posts in accordance with ASTM E985 as modified herein.
 - 2) Design of post base connection.
 - 3) Documentation that concrete anchors have been designed in accordance with one of the following:
 - a) ACI 318, Appendix D.
 - b) ICC Evaluation Services Report for selected anchor.
- B. Informational Submittals:
 - 1. Manufacturer's assembly and installation instructions.
 - 2. Special Inspection: Manufacturer's instructions for Special Inspection of post-installed anchors.

3. Test Reports: Test data may supplement load calculations providing data covers complete railing system, including anchorage:
 - a. Test data for railing and components showing load and deflection as a result of load, in enough detail to prove railing is strong enough and satisfies national, state, local standards, regulations, code requirements, and OSHA 29 CFR 1910, using design loads specified. Include test data for the following:
 - 1) Railing and post connections.
 - 2) Railing expansion joint connections.
 - b. Testing of anchorages shall be in accordance with ASTM E894 and ASTM E935 using applied loads in accordance with ICC IBC.
 - c. Deflection Criteria: In accordance with ASTM E985 and design loads specified, except as follows: maximum calculated lateral deflection at top of posts shall not exceed 1 inch.
 - d. Aluminum Rail Piping: Test data showing yield strength of pipe as delivered equals or exceeds specified values.
4. Manufacturer's written recommendations describing procedures for maintaining railings including cleaning materials, application methods, and precautions to be taken in use of cleaning materials.

1.05 QUALITY ASSURANCE

- A. Qualifications: Calculations required for design data shall be stamped by a registered civil or structural engineer licensed in state where Project will be constructed.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Package and wrap railings to prevent scratching and denting during shipment, storage, and installation. Maintain protective wrapping to the extent possible until railing is completely installed.
- B. Delivery:
 1. Shop assemble into practical modules of lengths not exceeding 24 feet for shipment.
 2. Deliver toeboards loose for field assembly.
 3. Deliver clear anodized railing pipe and posts with protective plastic wrap.

1.07 ENVIRONMENTAL REQUIREMENTS

- A. Thermal Movements: Allow for thermal movement resulting from the following maximum range in ambient temperature in design, fabrication, and installation of railings to prevent buckling, opening up of joints, over stressing of components, connections and other detrimental effects. Base design calculation on actual surface temperature of material as a result of both solar heat gain and night time sky heat loss. Temperature change is difference between high or low temperature and installation temperature.
1. Temperature Change Range: 70 degrees F, ambient; 100 degrees F, material surfaces.

PART 2 PRODUCTS

2.01 ALUMINUM RAILINGS

- A. General:
1. Furnish pre-engineered and prefabricated railing systems as shown on Drawings.
 2. Railing systems using pop rivets or glued railing construction are not permitted.
 3. Sand cast accessories and components are not permitted.
 4. Fasteners shall be AISI Type 316 stainless steel, unless otherwise noted.
- B. Rails, Posts, and Formed Elbows:
1. Extruded Alloy 6105-T5, 6061-T6, or equivalent.
 2. Tensile Strength: 38,000 psi, minimum.
 3. Yield Strength: 35,000 psi, minimum.
 4. Wall Thickness: 0.145 inch, minimum.
 5. Posts and railings shall be nominal 1-1/2-inch diameter (1.90-inch outside diameter).
- C. Accessories:
1. Fittings and Accessories:
 - a. Extruded, machined bar stock, permanent mold castings, or die castings of sufficient strength to meet load requirements.
 - b. Gauge metal components are not acceptable for load-resisting components.
 - c. Fittings shall match color of pipe in railings.
 2. Miscellaneous Extruded Aluminum Parts: Alloys 6063-T6, 6061-T6, or 6105 T5 aluminum, or equivalent, and of adequate strength for all loads.

3. Castings for Railings:
 - a. Cast Al-mag with sufficient strength to meet load and test requirements.
 - b. Anodizable grade finish with excellent resistance to corrosion when subjected to exposure of sodium chloride solution intermittent spray and immersion.
4. Post Anchorages:
 - a. Refer to standard details for types of post anchorages and minimum requirements.
 - b. Bolts at anchorages shall be minimum 1/2-inch diameter.
5. Fasteners: Stainless steel.

D. Finishes:

1. Pipe and Post: In accordance with AA DAF45, designation AA-M32-C22-A41.
2. Cast Fittings: In accordance with AA DAF45, designation AA-M10-C22-A41.

2.02 ANCHOR BOLTS, FASTENERS, AND CONCRETE ANCHORS

A. Locknuts, Washers, and Screws:

1. Elastic Locknuts, Steel Flat Washers, Round Head Machine Screws (RHMS): AISI Type 316 stainless steel.
2. Flat Washers: Molded nylon.

B. Concrete Anchors:

1. Stainless steel, AISI Type 316.
2. Post-installed anchors in accordance with Section 05 50 00, Metal Fabrications, unless otherwise specified herein.
3. Bolt Diameter: 1/2-inch, minimum.

2.03 FABRICATION

A. Shop Assembly:

1. Post Spacing: Maximum 4-foot horizontal spacing.
2. Railing Posts Bolted to Concrete:
 - a. In lieu of field cutting, provide approved fitting with sufficient post overlap, containing provisions for vertical adjustment.
 - b. Field fit-up is required.
3. Free of burrs, nicks, and sharp edges when fabrication is complete.
4. Welding is not permitted.

B. Shop/Factory Finishing:

1. Use same alloy for uniform appearance throughout fabrication for railings.
2. Railing and Post Fittings: Match fittings with color of pipe in railing.

C. Shop Assembly:

1. Shop assemble rails, posts, and formed elbows with a close tolerance for tight fit.
2. Fit dowels tightly inside posts.

D. Repair of Defective Work: Remove stains and replace defective Work.

PART 3 EXECUTION

3.01 GENERAL

- A. Field fabrication of aluminum railing systems is not permitted.
- B. Where required, provide railing posts longer than needed and field cut to exact dimensions required in order to satisfy vertical variations on actual structure.
- C. Install railing with base that provides plus or minus 1/4-inch vertical adjustment inside base fitting. If adjustment is required in field and exceeds plus or minus 1/4-inch, reduce post length not to exceed beyond bottom of lowest set-screw or bolt in base fitting.
- D. Modification to supporting structure is not permitted where railing is to be attached.
- E. Protection from Entrapped Water:
1. Make provisions in exterior and interior installations subject to high humidity to drain water from railing system.
 2. For posts mounted in concrete, bends, and elbows occurring at low points, drill weep holes of 1/4-inch diameter at lowest possible elevations, one hole per post or rail. Drill hole in plane of rail.

3.02 RAILING INSTALLATION

- A. Assembly and Installation: Perform in accordance with manufacturer's written recommendations for installation.

B. Expansion Joints:

1. Maximum intervals of 54 feet on center and at structural joints.
2. Slip joint with internal sleeve extending 2 inches beyond each side of joint. Provide 1/2-inch slip joint gap to allow for expansion.
3. Fasten to one side using 3/8-inch diameter set-screw. Place set-screw at bottom of pipe.
4. Locate joints within 12 inches of posts. Locate expansion joints in rails that span expansion joints in structural walls and floors supporting the posts.

C. Posts and Rails:

1. Surface Mounted Posts:
 - a. Bolt post baseplate connectors firmly in place.
 - b. Shims, wedges, grout, and similar devices for railing post alignment not permitted.
2. Set posts plumb and aligned to within 1/8 inch in 12 feet.
3. Set rails horizontal or parallel to slope of steps to within 1/8 inch in 12 feet.
4. Install posts and rails in same plane.
5. Remove projections or irregularities and provide a smooth surface for sliding hands continuously along top rail.
6. Use offset rail for use on stairs and platforms if post is attached to web of stringers or structural platform supports.
7. Support 1-1/2-inch rails directly above stairway stringers with offset fittings.

3.03 FIELD FINISHING

- A. Corrosion Protection: Prevent galvanic action and other forms of corrosion caused from direct contact with concrete and dissimilar metals by coating metal surfaces as specified in Section 09 90 04, Painting.

3.04 FIELD QUALITY CONTROL

- A. Post-installed anchors supporting railing systems require special inspection.
- B. Owner-Furnished Quality Assurance, in accordance with ICC IBC Chapter 17 requirements, is provided in the Statement of Special Inspections Plan on Drawings. Contractor responsibilities and related information are included in Section 01 45 33, Special Inspection Observation, and Testing.

3.05 CLEANING

- A. Wash railing system thoroughly using clean water and soap. Rinse with clean water.
- B. Do not use acid solution, steel wool, or other harsh abrasive.
- C. If stain remains after washing, restore in accordance with railing manufacturer's recommendations or replace stained railings.

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 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 04
PAINTING (CONDENSED)

PART 1 GENERAL

1.01 REFERENCES

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

1. NACE International (NACE): RP0188, Discontinuity (Holiday) Testing of New Protective Coatings on Conductive Substrates.
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. 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, Joint Surface Preparation Standard White Metal Blast Cleaning.
 - g. SP 6, Joint Surface Preparation Standard Commercial Blast Cleaning.
 - h. SP 7, Joint Surface Preparation Standard Brush-Off Blast Cleaning.
 - i. SP 10, Joint Surface Preparation Standard Near-White Blast Cleaning.
 - j. SP 11, Power Tool Cleaning to Bare Metal.
 - k. SP 12, Surface Preparation and Cleaning of Steel and Other Hard Materials by High- and Ultrahigh-Pressure Water Jetting 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. MDFT: Minimum Dry Film Thickness, mils.
4. MDFTPC: Minimum Dry Film Thickness per Coat, mils.
5. Mil: Thousandth of an inch.
6. PDS: Product Data Sheet.
7. PSDS: Paint System Data Sheet.
8. PVC: Polyvinyl Chloride.
9. SFPG: Square Feet per Gallon.
10. SFPGPC: Square Feet per Gallon per Coat.
11. SP: Surface Preparation.

1.03 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
 - a. Product 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) Furnish copies of paint system submittals to coating applicator.
 - 4) Indiscriminate submittal of manufacturer's literature is not acceptable.
 - b. Detailed chemical and gradation analysis for each proposed abrasive material.

1.04 QUALITY ASSURANCE

A. Applicator's Experience: Minimum 5 years' practical experience in application of specified products.

B. Regulatory Requirements:

1. Meet federal, state, and local requirements limiting 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.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials to Site in unopened containers that plainly show designated name, date of manufacture, color, and manufacturer.
- B. Store paints in a protected area that is heated or cooled to maintain temperature range recommended by paint manufacturer.

1.06 PROJECT CONDITIONS

- A. Environmental Requirements:
 - 1. Do not apply paint in temperatures outside of manufacturer's recommended maximum or minimum allowable, or in dust, smoke-laden atmosphere, damp or humid weather.
 - 2. Do not perform abrasive blast cleaning whenever relative humidity exceeds 85 percent, or whenever surface temperature is less than 5 degrees F above dewpoint of ambient air. Strictly adhere to coating manufacturer's recommendations.

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. Paint manufacturer shall be nationally recognized manufacturer of paints and protective coatings and regularly engaged in production of such materials that have essentially identical service conditions as this Project.
- B. Minimum of 5 years' verifiable experience in manufacture of specified products.

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. Material Quality: Manufacturer's highest quality products and suitable for the intended service.
2. Materials, Including Primer and Finish Coats: Produced by same paint manufacturer.
3. Thinners, Cleaners, Driers, and Other Additives: As recommended by paint manufacturer of particular coating.

B. Products:

| Product | Definition |
|-----------------------|---|
| Acrylic Latex | Single component, gloss as specified |
| Acrylic Sealer | Clear acrylic |
| Alkyd Enamel | Optimum quality, gloss or semigloss finish as specified, 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 |
| Epoxy Filler/Surfacer | 100 percent 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 | Converted epoxy primer containing rust-inhibitive pigments |

| Product | Definition |
|---------------------------|---|
| High Build Epoxy | Polyamidoamine epoxy, minimum 69% volume solids, capability of 4 MDFT 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 |
| 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 |
| Stain, Concrete | Acrylic, water repellent, penetrating stain |

2.05 COLORS

- A. Provide as selected by Owner.
- B. Formulate with colorants free of lead or lead compounds.
- C. Proprietary identification of colors is for identification only. Any authorized manufacturer may supply matches.

2.06 SHOP FINISHES

- A. Shop Blast Cleaning: Reference paragraph Shop Coating Requirements, this section.
- 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. Prior to blast cleaning, grind smooth surface imperfections including, but not limited to, delaminating metal or oxide layers.
 - c. Surface preparation and application of primer and finish coats shall be performed by pipe manufacturer.

PART 3 EXECUTION

3.01 GENERAL

A. Surface Preparation Inspection:

1. 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. In event of conflict, more stringent shall apply.
2. Notify Engineer minimum 7 days' prior to start of surface preparation work or coating application work.
3. Perform work only in presence of Engineer, unless Engineer grants prior approval to perform work in Engineer's absence.

B. 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.

C. The intention of these Specifications is for new, interior and exterior metal surfaces to be painted, whether specifically mentioned or not, except as modified herein.

3.02 PROTECTION OF MATERIALS NOT TO BE PAINTED

- A. Protect all surfaces adjacent to, or downwind of Work area from overspray. Contractor shall be responsible for any damages resulting from overspray.
- B. 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.
- C. Provide drop cloths to prevent paint materials from falling on or marring adjacent surfaces.
- D. Protect working parts of mechanical and electrical equipment from damage.
- E. Mask openings in motors to prevent paint and other materials from entering the motors.

3.03 FIELD SANDBLASTING

- A. Perform sandblasting for items and equipment where specified, and as required to restore damaged surfaces previously shop or field blasted and primed. Materials, equipment, procedures shall meet requirements of SSPC.

3.04 PREPARATION OF SURFACES

- A. Metal Surface Preparation:
 - 1. General:
 - a. Submit samples prior to surface preparation blasting.
 - b. Conform to current SSPC specifications as follows:
 - 1) Solvent Cleaning: SP 1.
 - 2) Hand Tool Cleaning: SP 2.
 - 3) Power Tool Cleaning: SP 3.
 - 4) White Metal Blast Cleaning: SP 5.
 - 5) Commercial Blast Cleaning: SP 6.
 - 6) Brush-Off Blast Cleaning: SP 7.
 - 7) Near-White Blast Cleaning: SP 10.
 - 8) Power Tool Cleaning to Bare Metal: SP 11.
 - 9) High Pressure Waterjetting: SP 12.
 - c. Where OSHA or EPA regulations preclude standard abrasive blast cleaning, wet- or vacu-blast methods may be required. Follow coatings manufacturers' recommendations for wet-blast additives and first coat application.
 - d. Hand-tool clean areas that cannot be cleaned by power-tool cleaning.

2. Blast Cleaning Requirements:
 - a. Comply with applicable federal, state, and local, air pollution and environmental control regulations for blast cleaning and disposition of spent aggregate and debris.
 - b. Alternatives to standard abrasive blast cleaning methods subject to Engineer review.

B. 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 concrete surfaces to remove loose concrete and to provide a tooth for binding. If brush-off blasting is impractical, surface may be acid etched with muriatic acid solution. Approval is subject to producing desired profile equivalent to No. 80 grit flint sandpaper. Acid etching of vertical or overhead surfaces will not be accepted.
5. Unless otherwise required for proper adhesion, ensure surfaces are dry prior to painting.

3.05 PAINT MIXING

A. Multiple-Component Coatings:

1. Prepare using contents of container for 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. Mix only components specified and furnished by paint manufacturer.
5. Do not intermix additional components for reasons of color or otherwise, even within same generic type of coating.

B. Keep paint materials sealed when not in use.

C. Where more than one coat of material is applied within given system, alternate color to provide visual reference that required number of coats has been applied.

3.06 PAINT APPLICATION

A. General:

1. Inspection: Schedule with Engineer in advance for cleaned surfaces and all coats prior to succeeding coat.
2. Apply coating in accordance with paint manufacturer's recommendations. Allow sufficient time between coats to ensure thorough drying of previously applied paint.
3. Fusion Bonded Coating Application: Electrostatic, fluidized bed, or flocking.
4. Paint units to be bolted together and to structures, prior to assembly or installation.
5. 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.

B. Shop Primed or Factory Finished Surfaces:

1. Inspection: Schedule inspection for compliance with Specifications of shop primed or factory finished items with Engineer in advance of delivery to Site.
2. Hand or power sand areas of chipped, peeled, or abraded coating, feathering the edges. Follow with a spot primer using specified primer.
3. For two-package or converted coatings, consult coatings manufacturer for specific procedures as relates to manufacturer's products.
4. Prior to application of finish coats, clean shop-primed surfaces free of dirt, oil, and grease and apply mist coat of specified primer, 1-mil dry film thickness.
5. After welding, prepare and prime holdback areas as required for specified paint system. Apply primer in accordance with manufacturer's instructions.

C. Manufacturer Applied Paint Systems:

1. Repair abraded areas on factory finished items in accordance with equipment manufacturer's directions.
2. Carefully blend repaired areas into original finish.

D. 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:
 - a. May be thinned to provide maximum penetration and adhesion.
 - b. Type and Amount of Thinning: Determined by paint manufacturer and dependent upon surface density and type of coating.
3. Surfaces Specified to Receive Water Base Coating: Damp, but free of running water, just prior to application of coating.

E. Film Thickness and Coverage:

1. Number of Coats:
 - a. Minimum required, irrespective of 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. Use wet film thickness gauge to measure proper coating thickness during application.
3. Film Thickness Measurement and Electrical Inspection of Coated Surface:
 - a. Perform with properly calibrated instruments.
 - b. Recoat and repair as necessary for compliance with Specifications.
 - c. Coats will be subject to inspection by Engineer and coating manufacturer's representative.
4. Visually inspect concrete, 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 thickness are likely to be present, and ensure proper millage in these areas.
6. Apply additional coats as required to complete hiding of underlying coats. Hiding shall be so complete that additional coats would not increase 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. Additional requirements are included in the Piping Schedule.

C. System No. 5 Exposed Metal—Mildly Corrosive:

| Surface Prep. | Paint Material | Min. Coats, Cover |
|--|---------------------|-------------------|
| SP 10, Near-White Metal Blast Cleaning | Epoxy Primer | 1 coat, 2.5 MDFT |
| | Polyurethane Enamel | 1 coat, 3 MDFT |

1. Use on the following items or areas:
 - a. Exposed metal surfaces, new and located inside or outside of structures and exposed to weather or in highly humid atmosphere, such as pipe galleries and similar areas:

D. 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, new and located inside or outside of structures and exposed to weather, including metal doors and frames, vents, louvers, interior metal ductwork, flashing, sheet metalwork and miscellaneous architectural metal trim:
 - b. Apply surface preparation and primer to surfaces prior to installation. Finish coats need only be applied to surfaces exposed after completion of construction.

E. System No. 19a 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 | Surface Tolerant Epoxy | 2 coats, 8 to 10 mils dry film thickness per coat, see Note 2. |
| <p>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.</p> <p>Note 2: Brush out surface voids and irregularities to provide a monolithic film.</p> | | |

1. Use this system on all exposed surfaces of saw-cut concrete that will not receive new concrete cover and within 2 inches of exposed metal or rebar. Entire cut surface may receive the system.

F. 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.

3.08 FIELD QUALITY CONTROL

A. Testing Equipment:

1. Provide magnetic type dry film thickness gauge, to test coating thickness specified in mils, as manufactured by Nordson Corp., Anaheim, CA; Mikrotest.
2. Provide electrical holiday detector, low voltage, wet sponge type, to test completed coating systems, 20 mils or less MDFT, for holidays and discontinuities as manufactured by Tinker and Rasor, San Gabriel, CA, Model M-1.

3. Provide high voltage holiday detector for coatings in excess of 20 mils MDFT. Unit as recommended by coating manufacturer.
- B. Testing:
1. Thickness and Continuity Testing:
 - a. Measure coating thickness specified in mils with magnetic type dry film thickness gauge in accordance with SSPC PA 2.
 - b. Check each coat for correct millage. Do not make measurement within 8 hours, minimum, after application of coating.
 - c. Test finish coat, 20 mils thick or less, except zinc primer, galvanizing, and elastomeric coatings, for holidays and discontinuities with electrical holiday detector, low voltage, wet sponge type in accordance with NACE RP0188.
 - d. Holiday detect coatings in excess of 20 mils MDFT with high voltage units recommended by coating manufacturer, and in accordance with NACE RP0188.
 - e. After repaired and recoated areas have dried sufficiently, retest each repaired area. Final test may also be conducted by Engineer.
- C. Unsatisfactory Application:
1. Clean and top coat surfaces found to have improper finish color or insufficient film thickness.
 2. Evidence of runs, bridges, shiners, laps, or other imperfections shall be cause for rejection.
 3. Repair defects in coating system per written recommendations of coating manufacturer.
 4. Leave staging up until Engineer has inspected surface or coating. Replace staging removed prior to approval by Engineer.
- D. Damaged Coatings, Pinholes, and Holidays:
1. Feather edges and repair in accordance with recommendations of paint manufacturer.
 2. Hand or power sand visible areas of chipped, peeled, or abraded paint, and feather edges. Follow with primer and finish coat in accordance with Specifications. Depending on extent of repair and appearance, finish sanding and topcoat may be required.
 3. Repair fusion bonded coatings as recommended by original applicator.
 4. Apply finish coats, including touchup and damage-repair coats, in a manner, which will present uniform texture and color-matched appearance.

3.09 CLEANUP

- A. Place cloths and waste that might constitute fire hazard in closed metal containers or destroy at end of each day.
- B. Upon completion of work, remove staging, scaffolding, and containers from Site or destroy in legal manner.
- C. Completely remove paint spots, oil, or stains from adjacent surfaces and floors and leave entire job clean.

3.10 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.: _____

SECTION 09 96 35
CHEMICAL-RESISTANT COATINGS

PART 1 GENERAL

1.01 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
 - a. List materials in proposed system.
 - b. Manufacturer's product specification.
 - c. Chemical resistance test results for exposure to service conditions.
 - d. Application instructions.
 - e. Configuration details of materials at terminations, construction joints, floor drains, and trenches.

B. Informational Submittals:

1. Letter from manufacturer stating applicator is qualified to do the Work and meets the quality assurance minimum experience requirements.
2. Sample of warranty, prior to starting the Work.
3. Installation instructions.
4. Field inspection and test reports.
5. Manufacturer's Certificate of Proper Installation, in accordance with Section 01 43 33, Manufacturers' Field Services.
6. Special guarantee.

1.02 QUALITY ASSURANCE

A. Manufacturer's Experience: Minimum 5 years manufacturing proposed products.

B. Applicator's Experience: Minimum 3 years applying proposed products.

1.03 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials in manufacturer's original, unopened containers.

B. Storage: Maintain materials in clean and dry condition. Follow manufacturer's instructions.

1.04 ENVIRONMENTAL REQUIREMENTS

A. Temperature: Apply coating only when substrate, ambient air, and coating material are 65 degrees F or above.

- B. Substrate: Not wet or have standing water.
- C. Ventilation: Provide during and after application to meet all applicable safety and health regulations.

1.05 EXTRA MATERIALS

- A. Furnish minimum 2 gallons of unopened topcoating material for future use by Owner.

1.06 SPECIAL GUARANTEE

- A. Furnish manufacturer's extended guarantee or warranty, with Owner named as beneficiary, in writing, as special guarantee. Special guarantee shall provide for correction, or at the option of the Owner, removal and replacement of Work specified in this Specification section found defective during a period of 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 SERVICE CONDITIONS

- A. Location:
 - 1. Liquid Lime System: Outdoors, exposed to weather and inside prefabricated lime feed building.
 - 2. Sodium Permanganate System: Inside prefabricated sodium permanganate storage and feed building.
- B. Surface:
 - 1. Liquid Lime System: Concrete floors, walls, and vault for chemical storage and handling.
 - 2. Sodium Permanganate System: Metal floors, grating supports and interior building walls.
- C. Traffic:
 - 1. Liquid Lime System: Foot, light hand truck, forklifts.
 - 2. Sodium Permanganate System: No regular traffic on coated surface.
- D. Chemicals Stored in Containment Areas:
 - 1. Lime slurry.
 - 2. Sodium Permanganate, 20 percent solution.

2.02 COATING SYSTEMS

- A. Chemical-Resistant Coatings: A mixture of liquid resin-based material, setting agent, and filler designed to be troweled into place to cure to a hard state.
- B. Mat-Reinforced Vinyl Ester (System CRC-1): Primer, fiberglass mat, saturant, and two trowel-applied coats of vinyl ester resin with silica fillers. Finished system thickness 150 mils minimum.
- C. Epoxy (System CRC-2): Primer and one trowel-applied coat of epoxy resin with silica fillers. Finished system thickness 100 mils minimum.
- D. CRC-5: A chemically-resistant, fiberglass-reinforced bisphenol F epoxy lining system. Finished system thickness 150 mils minimum.

2.03 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 04, Painting, 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-5: Use in the following areas:

1. All exposed horizontal and vertical concrete surfaces inside and on top of the lime slurry containment structure, including the top of the containment walls.

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 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.

2.02 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.
 - c. Rigid laminate.
 - d. Multi-layered acrylic.
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.

2.03 ANCILLARY MATERIALS

- A. Fasteners: Stainless steel screws or bolts of appropriate sizes.
- B. Wood Posts: Preservative treated 4 by 4 wood as specified in Section 06 10 00, Rough Carpentry.
- 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 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:

| Material | Health Hazard (Blue) | Flammability Hazard (Red) | Instability Hazard (Yellow) | Special Hazard (White) |
|------------------------------------|-----------------------------|----------------------------------|------------------------------------|-------------------------------|
| Liquid Lime (20% solution) | 1 | 0 | 0 | |
| Sodium Permanganate (20% solution) | 1 | 0 | 0 | OXY |

3.03 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.

3.04 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).

END OF SECTION

SIGN SCHEDULE

| SIGN SCHEDULE | | | | | | | | | | | | | |
|---|---------------------|-------|--------|--------|-----------|--------|---------------|-----------|-----------|-------|---|-------|---|
| Sign | | | | | | | | Lettering | | | | | Other Requirements |
| Type ¹ | Format ² | Size | | Color | Mounting | | | | | | | | |
| | | Width | Height | | Location | Method | Height to Top | Height | Style | Color | Message | Faces | |
| C | 1014-002 | 20" | 14" | Yellow | Hanging | Chain | 5'-6" | 1" min. | Helvetica | Black | CAUTION Equipment Starts Automatically | 1 | |
| C | 1014-001 | 20" | 14" | White | Wall | Bolts | 3'-6" | 1" min. | Helvetica | Black | DANGER Nonpotable Water Not for Drinking | 1 | Provide at interior W2 hose valves |
| B | 1014-001 | 20" | 14" | White | Pipe Post | Bolts | 3'-6" | 1" min. | Helvetica | Black | DANGER Nonpotable Water Not for Drinking | 1 | Provide at exteriorW2 hose valves |
| C | 1014-003 | 20" | 14" | Orange | Wall | Bolts | 5'-6" | 1" min. | Helvetica | Black | WARNING Corrosive Materials Wear Required Protection | 1 | |
| C | 1014-003 | 20" | 14" | Orange | Wall | Bolts | 5'-6" | 1" min. | Helvetica | Black | WARNING Eye Protection Required in this Area | 1 | |
| ¹ Letters refer to sign types specified in this section. ² Numbers refer to Design Details that show sign layout. ³ Verify requirements for this sign with Laws and Regulations in state where Project is located. | | | | | | | | | | | | | |

SECTION 13 34 23 FABRICATED STRUCTURES

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. American Institute of Steel Construction (AISC): 360, Specification for Structural Steel Buildings.
4. American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE):
 - a. 90A, Energy Conservation in New Building Design.
 - b. Fundamentals Handbook.
5. ASTM International (ASTM):
 - a. A497/A497M, Standard Specification for Steel Welded Wire Reinforcement, Deformed, for Concrete.
 - b. A615/A615M, Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.
 - c. C150, Standard Specification for Portland Cement.
 - d. C94/C94M, Standard Specification for Ready-Mixed Concrete.
 - e. C920, Standard Specification for Elastomeric Joint Sealants.
 - f. E84, Standard Test Method for Surface Burning Characteristics of Building Materials.
 - g. E2190, Standard Specification for Insulating Glass Unit Performance and Evaluation.
6. International Code Council (ICC): International Building Code (IBC).
7. National Institute of Standards and Technology-Product Standards Section (PS): 15, Custom Contact-Molded Reinforced Polyester Chemical-Resistant Process Equipment.
8. National Fire Protection Association (NFPA):
 - a. 10, Portable Fire Extinguishers.
 - b. 13, Installation of Sprinkler Systems.
 - c. 70, National Electrical Code.
 - d. 90A, Standard for Installation of Air Conditioning and Ventilating Systems.
 - e. 90B, Standard for the Installation of Warm Air Heating and Air-Conditioning Systems.
 - f. 101, Life Safety Code.

9. Steel Door Institute (SDI): 100, Recommended Specifications, Standard Steel Doors and Frames.

1.02 SYSTEM DESCRIPTION

- A. Building Name: Sodium Permanganate Storage and Feed Building.
 1. Size:
 - a. Exterior, Nominal: 11 feet 4 inches wide by 21 feet 4 inches long by 12 feet high.
 - b. Interior, Minimum: 10 feet 4 inches by 20 feet 4 inches.
 - c. Clear Ceiling Height: 10 feet 1 inch.
 2. Roof Slope: Manufacturer's standard to facilitate rain runoff.
 3. Include: Doors, door frame, and associated hardware. Corrosive environment paint on all interior metal surfaces.
 - b. Building envelope insulation for floor, walls, and roof.
 - c. Fiberglass floor grating.
 - d. Integral sump basin.
 - e. Steel sump separator.
 - f. Equipment as indicated.
 - g. Load center as indicated.
 - h. Building lights and receptacles.
 - i. Building access ramp with handrails.
- B. System: Design, furnish, and install complete building package using manufacturer's standard components unless otherwise specified.
- C. Structure: Fabricated metal environmental enclosure designed to be moved and installed as a single unit.
- D. Design: Coordinate enclosure design with function to be enclosed.
- E. Control indoor air quality and provide electrical illumination and power.

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 building system.

- c. Painting and Coating Systems: Specifications including paint manufacturer's name, product trade-name, and preparation for shop and field coats.
- d. Certification from paint manufacturer that chemical resistant coating is appropriate for the specified environment.
- e. Drawings stamped by Contractor's engineer and prepared specifically for this Project:
 - 1) Materials and Details: Show materials, details of components (including doors and other accessories), finishes, fastenings, methods of joining, sealants, anchor bolt, shear angle, and baseplate details, including all sizes and dimensions, size and location of structural members and bracing, wall structural members, bracing, openings, and structural wind columns as required.
- f. Calculations Stamped by Contractor's Engineer:
 - 1) Complete structural stress and deflection analysis of structural components and connections; for bolted moment-resistant connections in main frames consider prying action of bolts. Include all applicable load combinations from the IBC, including both gravity and lateral (wind and seismic) loads.
 - 2) Building anchorage calculations in accordance with the IBC and Specification 01 88 15, Anchorage and Bracing.
 - 3) Heat loss calculations showing conformance with applicable code.
- 2. Samples: Colors of metal siding and interiors 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: Engineer 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 the current versions of:
 1. International Building Code as amended by the State of Georgia.
 2. International Energy Conservation Code as amended by the State of Georgia.
 3. International Plumbing Code as amended by the State of Georgia.
 4. International Fire Code as amended by the State of Georgia.
 5. International Mechanical Code as amended by the State of Georgia.
 6. NFPA 70, National Electrical Code.

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: Finish on metal roof and wall panels, flashing, and trim will not chalk, crack, check blister, peel, flake, chip, or lose adhesion for 5 years. Roofing will remain weathertight for 20 years.

PART 2 PRODUCTS

2.01 BUILDING SYSTEM MANUFACTURERS

- A. Products of the following, meeting these Specifications, may be used on this Project:
 - 1. U.S. Chemical Storage.
 - 2. Approved equal.

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 and Tanks: As located on the Drawings.
 - 3. Floor Live Load: 300 psf.
 - 4. Roof Snow Load: See the Structural General Notes in the Drawings.
 - 5. Design Wind Loads: See the Structural General Notes in the Drawings.
 - 6. Earthquake Load See the Structural General Notes in the Drawings.
- B. Outside Design Conditions:
 - 1. Temperature:
 - a. Winter DB, 18 degrees F.
 - b. Summer DB, 91 degrees F.
 - c. Summer WB, 74 degrees F.

2.03 COMPONENTS

- A. Substructure: Cast-in-place concrete foundation, see the Drawings.
- B. Shell:
 - 1. Provide weathertight structure that has straight, plumb walls with square corners.
 - 2. Allowable Average Heat Loss: Minimum R-value of 7.7 hr/sq ft/degree F/Btu.
 - 3. Slope roof to drain.
- C. Interiors:
 - 1. Floor: FRP grating. Grating sections sized such that they can be removed by a single person.
 - 2. Walls and ceiling: Vertical, smooth surface with minimum joints or seams, painted with corrosion resistant paint.

3. Flame Spread: ASTM E84 rating of 25 or less.

D. Equipment and Furnishings:

1. Static grounding system.
2. Signage.
3. HVAC system.
4. Electrical load center.
5. Electrical disconnect.
6. Duplex receptacles.
7. Exterior light fixture.
8. Interior light fixtures.
9. Automatic fire suppression sprinkler system.
10. Outdoor liquid level detector fire alarm/strobe.
11. Outdoor eyewash/shower unit fire alarm/strobe.
12. Liquid level detector with remote annunciation.
13. Wall Mounted Channels: Provide wall mounted channels as shown in the Drawings. Design each attachment to structure for a 500 pound live load in any direction.
14. Tank Supports: Provide supports for tanks as shown in the Drawings. Supports shall permit anchoring of the tank for resistance to seismic loads. Coordinate anchor locations with the tank supplier.

E. Plumbing Systems:

1. Combination shower/eyewash station suited with emergency alarm system.
 - a. Type: Stainless Steel.
 - b. Shower Head: ABS Plastic.
 - c. Valve: Instant-open ball valve with large push-type plate. Valve remains open until manually closed. Extension shaft for valve handle designed to operate below frost line.
 - d. Less receptor.
 - e. Heads: Stainless steel designed to direct steady flow of water to eyes and ocular area of face with dust covers.
 - f. Supply: 1-1/4-inch stainless steel IPS for shower and eyewash.
 - g. Waste: 1-1/4-inch IPS tailpiece, spill onto floor.
 - h. Flow Switches, Audible and Visible Alarms:
 - 1) Type: Double pole, double throw, NEMA 4X, UL listed paddle type flow switch. Contacts to be rated for five amps at 120V ac.

- 2) Flow switches shall be furnished by the emergency shower and eyewash stations manufacturer to ensure compatibility and proper sensing of flows from shower, eyewash or combination of the two flows from a combination station. Contractor shall assume complete responsibility for the proper operation of the flow sensing of the eyewash and shower units if flow switches other than furnished or recommended by the emergency shower and eyewash stations manufacturer may be used.
 - 3) Flow switch in a combination station shall sense flow for either shower or eyewash or combination of the two flows. Flow switches shall be full line size so as not restrict water flow in order to detect flow.
 - 4) Visible alarm shall be an amber flashing light, UL listed.
 - 5) Audible alarm shall be an intermittent signal rated at 85 dB at 10 feet.
2. Electric water heater.
 - a. Automatic, vertical, electric storage type.
 - b. Regulatory Compliance: UL Listed, ASME, ASHRAE 90.1, and NSF.
 - c. Tank: Steel, 1/2-inch Hydrastone Cement lined, 150 psig working pressure, and ASME rated.
 - d. Insulation: 3-inch thick polyurethane foam.
 - e. Dip Tube: Required on inlet connection down to bottom section of tank.
 - f. Pressure/Temperature Relief Valve: ASME rated.
 - g. Connections: Copper-silicon alloy tappings.
 - h. Heating Element: Copper sheathed; immersion type.
 - i. Controls: Fully automatic, house in control panel.
 - j. Capacity: 120 gallon, at 180 degrees F water, 6.0 KW, 208-volt, 1-phase.
 - k. Outer protective jacket shall be dent resistant.
 - l. Dial temperature and pressure gauge.
 - m. Automatic air valve.
 - n. Manufacturer: Hubbell EMV, Therm-Omega-Tech, Inc. or Equal.
 3. Tepid Water Mixing Valve:
 - a. Type: Thermostatically operated water-blending device.
 - b. Materials:
 - 1) Body: Brass.
 - 2) Vanes: Brass.
 - 3) Cabinet: Stainless steel.
 - c. Thermostatic element to be located in main body of valve.
 - d. Outlet dial thermometer.
 - e. Locking temperature regulator set at 105 degrees F.
 - f. Internal cold water bypass and temperature override protection.

- g. Minimum Flow: 3 gpm.
 - h. Maximum Supply Pressure: 125 psi.
 - i. Maximum Supply Temperature: 180 degrees F.
 - j. References: ANSI Z358-1 and NSF/ANSI 61-G.
 - k. Manufacturer: Powers, Leonard Water Temperature Controls or Equal.
4. Hose bib:
- a. Type: Indoor/non-freeze area boiler drain globe valve, chrome plated.
 - b. Materials: Bronze body, screwed bonnet, renewable composition disc.
 - c. End Connections: Hose thread outlet, male pipe thread or sweat inlet.
 - d. Manufacturer: Mueller Industries, Nibco Incorporated or Equal.
5. Vacuum breaker:
- a. Type: Non-removable, atmospheric.
 - b. Materials: Brass body, stainless steel trim, silicone rubber diaphragm and disc.
 - c. End Connections: Hose thread inlet and outlet.
 - d. Reference: NSF/ANSI 61-G.
6. Backflow preventer assembly with drain piped to outside.
- a. Type: Reduced pressure zone device with two independently acting check valves, together with an automatically operated pressure differential relief valve located between the two check valves.
 - b. Body: Bronze or cast-iron.
 - c. Valve Discs: Buna-N rubber.
 - d. Diaphragm: Silicon rubber or Buna-N rubber.
 - e. Maximum Working Pressure: 175 psi.
 - f. End Connections: Screwed or flanged.
 - g. Air gap drain funnel with threaded outlet and vent below furnished by manufacturer.
 - h. Strainer with blow-off on inlet.
 - i. Outside screw and yoke gate valves on inlet and outlet.
 - j. References: ASSE 1013, AWWA C511, NSF/ANSI 61-G and authority having jurisdiction at the Site.
 - k. Manufacturer: Wilkins, Watts Regulator Company or Equal.
7. Water Pressure Reducing Valve.
- a. Spring controlled, with a neoprene diaphragm.
 - b. Reference: NSF/ANSI 61-G
 - c. Manufacturer: Fisher, Watts or Equal.

F. Heating, Ventilating, and Air Conditioning Systems:

1. General:
 - a. Furnish heating and air-conditioning system to maintain inside temperature between 50 and 85 degrees and between 50 and 70 percent relative humidity.
 - b. Furnish ventilation system to provide a rate not less than 1 CFM per square foot.
2. Wall Mounted Air-Conditioning Unit:
 - a. Self-contained wall-mounted air-conditioner suitable for outdoor use.
 - b. Unit shall be completely factory assembled and tested and shall include compressor, indoor and outdoor coils, fans, motors, prewired controls, interconnecting refrigerant tubing, wiring, circuit breaker, and other necessary components mounted in a corrosion resistant cabinet.
 - c. Unit Cabinet: Galvanized steel sheet metal with factory applied corrosion resistant finish.
 - d. Sloped top with built in mounting flanges.
 - e. Unit Mounting Brackets: Full-length bracket shall be factory provided.
 - f. Conditioned air section shall be insulated with 1/2-inch, 2-pound dual density fiberglass.
 - g. Supply Grille: Adjustable aluminum double deflection type, factory installed.
 - h. Return Grille: Aluminum, fixed blade type, factory installed.
 - i. Compressor: Hermetic type, equipped with an immersion type self regulating crankcase heater. Motor shall be protected by an internal line-break thermostat. Electrical wiring connections at the compressor shall be protected by receptacle housing.
 - j. Coils: Condenser and evaporative coil constructed of aluminum plate fins mechanically bonded to seamless copper tubes.
 - k. Fan: Direct driven, slow speed propeller type. Motor shall be equipped with a thermal protector.
 - l. Electric Heat Coil: UL listed and heavy-duty nickel-chromium elements. HIGH limit control operating through heating element contactors, equipped with automatic reset.
 - m. DX cooling capacity: 24,000 Btu/hr.
 - n. Electric Heater capacity: 10KW.
 - o. 208V/3-Phase.
 - p. 5-year compressor warranty.
 - q. Refrigerant R-410A.
 - r. Filter: 2-inch pleated throwaway type filter, mounted internally.
 - s. Manufacturer: Marvair, Bard or Equal.

3. Wall mounted exhaust fan:
 - a. Ventilation for the building shall be provided via wall mounted exhaust fan and intake louver for make-up air located 12 inches from floor.
 - b. Type: Wall mounted propeller fan.
 - c. Capacity: Minimum of 250 CFM.
 - d. Static Pressure: 0.25 IWC.
 - e. 120V/1 Phase.
 - f. Direct Drive.
 - g. Disconnect provided by equipment manufacturer.
 - h. All aluminum construction.
 - i. Gravity backdraft damper.
 - j. Motor side guard.
 - k. Provide on/off switch for fan control outside next to door.
 - l. Manufacturer: Aerovent, Greenheck or Equal.
4. Fire Protection: Furnish automatic sprinkler system in accordance with NFPA 13.
5. Furnish portable fire extinguisher per NFPA 10:
 - a. Multipurpose Hand Extinguisher (F. Ext-1):
 - 1) Tri-class dry chemical extinguishing agent.
 - 2) Pressurized, red enameled steel shell cylinder.
 - 3) Activated by top squeeze handle.
 - 4) Agent propelled through hose or opening at top of unit.
 - 5) For use on A, B, and C class fires.
 - 6) Minimum UL Rating: 4A-60B:C, 10-pound capacity.

G. Electrical Systems:

1. Three-phase, four wire, 120/208 volts, 60-Hz. Provide UL listed load center in NEMA 3R rain proof and sleet resistant enclosure mounted on exterior of building. Load center shall be provide with 125A main circuit breaker and feeder breakers as shown on Contract Documents. Panel shall power all components provided with enclosure such as water heater, lights, fan, and HVAC. In addition feeder breakers are provided for process equipment mounted in enclosure as shown on Contract Documents. Where indicated on panel schedule in Contract Documents, provide Equipment Ground Fault Interrupter (EGFI) rated breakers. EGFI breakers have ground fault sensor and rated to trip on 30 mA ground fault (UL listed for equipment ground fault protection).
2. Illumination Level: At 36 inches above floor, 50 footcandles minimum from fluorescent luminaires, plus task lights where there are shadows of people or equipment from general lighting. Provide LED EXIT light at door as required to meet life safety code.
3. Provide weather proof/vapor proof exterior light fixture at mandoor. Complete with integral photo cell.

4. Vendor shall provide all conduit and wire from load center to building provided system. All conduit and conductors shall meet requirements of Section 26 05 01, Electrical. Conduit shall be PVC Schedule 40 and conductors shall be stranded copper, THHN insulation.

H. Colors: As selected by Owner.

2.04 MATERIALS

- A. Fiberglass: Meet requirements of Voluntary Product Standard PS-15.
- B. Roofing: Manufacturer's standard metal with corrosion resistant paint.
- C. Sealant: Manufacturer's standard.
- D. Hollow Metal Doors, Frames, and Hardware:
 1. Size: Double leaf, 6 feet 0 inches wide by 7 feet high by 1-3/4 inches thick.
 2. Furnish Manufacturer's standard 1-1/2 hour fire rated steel frames and full flush hollow metal doors.
 3. Furnish hardware including hinges, cylindrical lock sets keyed into Owner's existing system, automatic closing devices, full weatherstripping, and thresholds, as applicable.
- E. Finishes:
 1. Flooring: T-Bar type fiberglass floor grating. Provide grating in sections that can be removed and handled by a single individual. Sections not to exceed 50 pounds.
 2. Coatings: Corrosive environment paint on all interior metal surfaces in accordance with Section 09 96 35, Chemical-Resistant Coatings.

2.05 SOURCE QUALITY CONTROL

- A. Inspections: Before shipment, inspect for complete, functional assembly.
- B. Tests: Perform manufacturers' standard tests and adjustments on mechanical and electrical equipment and other moving and operating components.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine Site and access to determine effect on proposed building.
- B. Investigate soils conditions and their effect on proposed building.

3.02 PREPARATION

- A. Verify Site conditions and make necessary field measurements.
- B. Perform Site modifications to suit installation of prefabricated building.
- C. Construct foundation.

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 HEATING AND VENTILATING

- A. Install equipment and components following manufacturer's instructions and recommendations.
- B. Meet requirements of NFPA 90A and NFPA 90B.
- C. Adjust for proper operation and control.

3.05 PLUMBING SYSTEMS

- A. Meet requirements of local plumbing code.
- B. Install products in accordance with manufacturers' instructions and recommendations.

3.06 ELECTRICAL SYSTEMS

- A. Meet requirements of National Electrical Code, NFPA 70.
- B. Install products in accordance with manufacturers' instructions and recommendations.
- C. Provide grounding for building by connecting to the substation ground grid.

3.07 FIELD QUALITY CONTROL

- A. Special Inspection: In accordance with Specification 01 45 33, Special Inspection, Observation, and Testing.

- B. Functional Tests: Conduct on moving and operating components.
- C. Performance Tests: Test and balance HVAC system.
- D. Electrical Continuity: Test continuity of completed metal structure and installed equipment to ground.

3.08 MANUFACTURER'S SERVICES

- A. Provide manufacturers' representatives at Site in accordance with Section 01 43 33, Manufacturers' Field Services, 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.

3.09 CLEANING/ADJUSTING

- A. Adjust moving and operating components for smooth operation.
- B. Thoroughly clean interior and exterior of building and leave weathertight and ready for use.

3.10 PROTECTION

- A. Protect installed products from damage.

END OF SECTION

SECTION 26 05 01 ELECTRICAL

PART 1 GENERAL

1.01 REFERENCES

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

1. ASTM International (ASTM):
 - a. A167, Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.
 - b. A240/A240M, Standard Specification for Heat-Resisting Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels.
 - c. A1011/A1011M, Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability.
 - d. B8, Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft.
 - e. C857, Standard Practice for Minimum Structural Design Loading for Underground Precast Concrete Utility Structures.
2. Federal Specifications (FS):
 - a. W-C-596, Connector, Electrical, Power, General Specification for.
 - b. W-S-896, Switch, Toggle (Toggle and Lock), Flush Mounted (General Specification).
3. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
 - a. C62.41, Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits.
 - b. PC62.41.1, Draft Guide on the Surge Environment in Low-Voltage (1000 V and less) AC Power Circuits.
 - c. 112, Standard Test Procedure for Polyphase Induction Motors and Generators.
 - d. 114, Standard Test Procedures for Single-Phase Induction Motors.
4. International Electrical Testing Association (NETA): ATS, Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.
5. National Electrical Contractors Association, Inc. (NECA): 1, Standard Practices for Good Workmanship in Electrical Contracting.
6. National Electrical Manufacturers Association (NEMA):
 - a. C80.1, Rigid Steel Conduit-Zinc Coated.
 - b. C80.3, Electrical Metallic Tubing-Zinc Coated.
 - c. C80.6, Intermediate Metal Conduit-Zinc Coated (IMC).
 - d. 250, Enclosures for Electrical Equipment (1,000 Volts Maximum).

- e. CC1, Electrical Power Connectors for Substations.
- f. ICS 1, Industrial Control and Systems: General Requirements.
- g. ICS 2, Industrial Control and Systems: Controllers, Contactors, and Overload Relays Rated Not More Than 2000 Volts AC or 750 Volts DC.
- h. ICS 2.3, Industrial Control and Systems: Instructions for the Handling, Installation, Operation and Maintenance of Motor Control Centers.
- i. MG 1, Motors and Generators.
- j. RN 1, Polyvinyl Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit.
- k. TC 2, Electrical Polyvinyl Chloride (PVC) Tubing and Conduit.
- l. TC 3, PVC Fittings for Use with Rigid PVC Conduit and Tubing.
- m. WC 55, Instrumentation Cables and Thermocouple Wire.
- n. WC 70, Standard for Non-Shielded Power Cables Rated 2000 V or Less for the Distribution of Electrical Energy.
- o. WD 1, General Color Requirements for Wiring Devices.
- 7. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC).
- 8. Underwriters Laboratories, Inc. (UL):
 - a. 1, Flexible Metal Conduit.
 - b. 6, Electrical Rigid Metal Conduit—Steel.
 - c. 62, Flexible Cord and Fixture Wire.
 - d. 98, Enclosed and Dead-Front Switches.
 - e. 360, Liquid-Tight Flexible Steel Conduit.
 - f. 486A, Wire Connectors and Soldering Lugs for Use with Copper Conductors.
 - g. 486C, Splicing Wire Connectors.
 - h. 489, Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit Breaker Enclosures.
 - i. 508, Industrial Control Equipment.
 - j. 510, Polyvinyl Chloride, Polyethylene and Rubber Insulating Tape.
 - k. 514B, Fittings for Cable and Conduit.
 - l. 651, Schedule 40 and 80 PVC Conduit.
 - m. 943, Ground-Fault Circuit Interrupters.
 - n. 1059, Terminal Blocks.
 - o. 1277, Electrical Power and Control Tray Cables with Optional Optical-Fibre Members.
 - p. 1449, Transient Voltage Surge Suppressors.
 - q. 1561, Dry-Type General Purpose and Power Transformers.
 - r. 2111, Overheating Protection for Motors.

1.02 DEFINITIONS

- A. AHJ: Authority Having Jurisdiction.
- B. TVSS: Transient Voltage Surge Suppressor.

1.03 SUBMITTALS

A. Action Submittals:

1. Boxes and device plates.
2. Junction and pullboxes.
3. Precast handholes.
4. Circuit breakers and switches.
5. Motor-rated switches.
6. Control devices, terminal blocks, and relays.
7. Contactors.
8. Support and framing channels.
9. Nameplates and nameplate schedule.
10. TVSS equipment.
11. Conduit, fittings, and accessories.
12. Wireways.
13. Conductors, cable, and accessories.
14. Motors: Nameplate data, detailed information on any special features.
15. Grounding materials.
16. Motor Controls: Arrangement drawings, ratings, schematic and wiring diagrams, bill of materials, nameplate schedule, manufacturer information on components.
17. Local Control Panels: Arrangement drawings, schematic and wiring diagrams, bill of materials, nameplate schedule, manufacturer information on components.
18. 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.
3. Factory test reports.
4. Field test reports.
5. Signed permits indicating Work is acceptable to regulatory authorities having jurisdiction.

6. Operation and Maintenance Data:
 - a. As specified in Section 01 78 23, Operation and Maintenance Data.
 - b. Provide for all equipment, as well as each device having features that can require adjustment, configuration, or maintenance.
 - c. Minimum information shall include manufacturer's preprinted instruction manual, one copy of the approved submittal information for the item, tabulation of any settings, and copies of any test reports.

1.04 APPROVAL BY AUTHORITY HAVING JURISDICTION

- A. Provide the Work in accordance with NFPA 70, National Electrical Code (NEC). Where required by the Authority Having Jurisdiction (AHJ), material and equipment shall be labeled or listed by a nationally recognized testing laboratory or other organization acceptable to the AHJ, in order to provide a basis for approval under the NEC.
- B. Materials and equipment manufactured within the scope of standards published by Underwriters Laboratories, Inc. shall conform to those standards and shall have an applied UL listing mark or label.

1.05 QUALIFICATIONS

- A. PVC-Coated, Rigid Steel Conduit Installer: Must be certified by conduit manufacturer as having received minimum 2 hours of training on installation procedures.
- B. Testing Firm Qualifications: Professionally independent of manufacturers, suppliers, and installers, or electrical equipment and systems being tested.

PART 2 PRODUCTS

2.01 GENERAL

- A. Products shall comply with all applicable provisions of NFPA 70.
- B. Like Items of Equipment: End products of one manufacturer in order to achieve standardization for appearance, operation, maintenance, spare parts, and manufacturer's service.
- C. Equipment and Devices Installed Outdoors or in Unheated Enclosures: Capable of continuous operation within ambient temperature range of 0 degree F to 104 degrees F.

D. Equipment Finish:

1. Manufacturer's standard finish color, except where specific color is indicated.
2. If manufacturer has no standard color, finish equipment in accordance with, light gray color finish as approved by Owner.

2.02 OUTLET AND DEVICE BOXES

A. Sheet Steel: One-piece drawn type, zinc- or cadmium-plated.

B. Cast Metal:

1. Box: Cast ferrous metal.
2. Cover: Gasketed, weatherproof, and cast ferrous metal with stainless steel screws.
3. Hubs: Threaded.
4. Lugs: Cast Mounting.
5. Manufacturers and Products, Nonhazardous Locations:
 - a. Crouse-Hinds; Type FS or FD.
 - b. Appleton; Type FS or FD.
6. Manufacturers and Products, Hazardous Locations:
 - a. Crouse-Hinds; Type GUA or EAJ.
 - b. Appleton; Type GR.

C. PVC-Coated Cast Metal:

1. Type: One-piece.
2. Material: Malleable iron, cast ferrous metal, or cast aluminum.
3. Coating:
 - a. All Exterior Surfaces; 40 mils PVC.
 - b. All Interior Surfaces, 2 mils urethane.
4. Manufacturers:
 - a. Robroy Industries.
 - b. Ocal.

2.03 JUNCTION AND PULL BOXES

- A. Outlet Boxes Used as Junction or Pull Box: As specified under Article Outlet and Device Boxes.
- B. Conduit Bodies Used as Junction Boxes: As specified under Article Conduit and Fittings.

C. Large Cast Metal Box:

1. NEMA 250, Type 4.
2. Box: Cast ferrous metal, electrogalvanized finished, with drilled and tapped conduit entrances and exterior mounting lugs.
3. Cover: Hinged with clamps.
4. Gasket: Neoprene.
5. Hardware and Machine Screws: ASTM A167, Type 316 stainless steel.
6. Manufacturers and Products, Surface Mounted Nonhinged Type:
 - a. Crouse-Hinds; Series W.
 - b. O-Z/Gedney; Series Y.
7. Manufacturer and Product, Surface Mounted, Hinged Type:
O-Z/Gedney; Series YW.
8. Manufacturers and Products, Recessed Type:
 - a. Crouse-Hinds; Type WJBF.
 - b. O-Z/Gedney; Series YR.

D. Large Stainless Steel Box:

1. NEMA 250, Type 4X.
2. Box: 14-gauge, ASTM A240, Type 316 stainless steel Cover: Hinged with clamps.
3. Hardware and Machine Screws: ASTM A167, Type 316 stainless steel.
4. Manufacturers:
 - a. Hoffman Engineering Co.
 - b. Robroy Industries.

E. Concrete Box, Nontraffic Areas:

1. Box: Reinforced, cast concrete with extension.
2. Cover: Steel diamond plate with locking bolts.
3. Cover Marking: ELECTRICAL, TELEPHONE, or as shown.
4. Size: 10 inch by 17 inch (minimum).
5. Manufacturer and Product: Utility Vault Co.; Series 36-1017PB, with cover DP.

2.04 PRECAST HANDHOLES

A. Construction: Precast concrete.

B. Loading: AASHTO H-10 or H-20, as noted below, in accordance with ASTM C857.

- C. Drainage:
 - 1. Slope floors toward drain points leaving no pockets or other nondraining areas.
 - 2. Provide drainage outlet at low point of floor.
- D. Raceway Entrances: Provide knockout panels on all four sides.
- E. Handhole Frames and Covers:
 - 1. Material: Steel, hot-dipped galvanized.
 - 2. Cover Type: Solid, bolt-on or hinged, of checkered design, as noted below.
 - 3. Cover Loading: As noted below.
 - 4. Cover Designation: Lettering minimum 2 inches in height, as shown.
- F. Hardware: Steel, hot-dip galvanized.
- G. Furnish knockout for ground rod in each handhole.
- H. Manufacturer and Models: Utility Vault Company.
 - 1. Small: H-10 incidental traffic loading; Model 3030-B with 3030-DP cover.
 - 2. Large: H-20 off-street traffic loading; Model 444-LA with 44-332P cover.

2.05 CIRCUIT BREAKER, INDIVIDUAL, 0 TO 600 VOLTS

- A. UL 489 listed for use at location of installation.
- B. Minimum Interrupt Rating: As shown.
- C. Thermal-magnetic, quick-make, quick-break, indicating type showing ON/OFF and TRIPPED indicating positions of operating handle.
- D. Suitable for use with 75 degrees C wire at full NFPA 70, 75 degrees C ampacity.
- E. Locking: Provisions for padlocking handle.
- F. Enclosure: As specified under Execution.
- G. Interlock: Enclosure and switch shall interlock to prevent opening cover with breaker in the ON position.

H. Manufacturers:

1. Eaton.
2. General Electric Co.
3. Square D Co.

2.06 NONFUSED SWITCH, INDIVIDUAL, 0 TO 600 VOLTS

A. NEMA KS 1.

B. Quick-make, quick-break, motor rated, load-break, heavy-duty (HD) type with external markings clearly indicating ON/OFF positions.

C. Suitable for use with 75 degrees C wire at full NFPA 70, 75 degrees C ampacity.

D. Enclosure: As specified under Execution.

E. Interlock: Enclosure and switch to prevent opening cover with switch in the ON position.

F. Manufacturers:

1. Eaton.
2. General Electric Co.
3. Square D Co.

2.07 SWITCH, MOTOR-RATED

A. Type: Two- or three-pole, manual motor starting/disconnect switch without overload protection.

B. Enclosure/Mounting and Rating:

1. General Purpose:
 - a. Totally enclosed snap-action switch. Quick-make, slow-break design with silver alloy contacts. Listed UL 508.
 - b. General Purpose Rating: 30 amperes, 600V ac.
 - c. Minimum Motor Ratings:
 - 1) 2 hp for 120V ac, single-phase, two-pole.
 - 2) 3 hp for 240V ac, single-phase, two-pole.
 - 3) 15 hp for 480V ac, three-phase, three-pole.
 - d. Screw-type terminals.

C. Manufacturers:

1. General Purpose:
 - a. Bryant.
 - b. Hubbell.
2. Explosion-proof: Eaton, Type B101.

2.08 PUSHBUTTONS, INDICATING LIGHTS, AND SELECTOR SWITCHES

A. Type: Heavy-duty, oiltight. Provide contact arrangements, colors, inscriptions, and functions as shown.

B. Contact Rating: NEMA ICS 2, Type A600.

C. Unless otherwise shown, provide the following features:

1. Selector Switch Operating Lever: Standard.
2. Indicating Lights: Push-to-test, transformer-type.
3. Pushbutton Color:
 - a. ON or START: Black.
 - b. OFF or STOP: Red.
4. Pushbuttons and selector switches lockable in OFF position where indicated.

D. Legend Plate:

1. Material: Aluminum.
2. Engraving: Indicating specific function, or as shown.
3. Letter Height: 7/64 inch.

E. Manufacturers and Products:

1. General Electric Co.; Type CR 104P.
2. Square D Co.; Type T.
3. Eaton; Type 10250T.

2.09 TERMINAL BLOCKS

A. Type: UL 1059. Compression screw clamp, with current bar providing direct contact with wire and yoke, with individual rail mounted terminals. Marking system shall permit use of preprinted or field-marked tags.

B. Yokes and Clamping Screws: Zinc-plated, hardened steel.

C. Rating: 600V ac.

D. Manufacturers:

1. Weidmuller, Inc.
2. Ideal.

2.10 MAGNETIC CONTROL RELAYS

A. NEMA ICS 2, Class A600 (600 volts, 10 amperes continuous, 7,200VA make, 720VA break), machine tool type with field convertible contacts.

B. Manufacturer and Model:

1. Eaton; Type M-600.
2. General Electric; Type CR120B.

2.11 TIME DELAY RELAY

A. Industrial Relay Rated: 150 volts, 5 amps continuous, (3,600 VA make, 360 VA break).

B. Solid-state electronic, field convertible ON/OFF delay.

C. Two Form-C contacts (minimum).

D. Repeat accuracy plus or minus 2 percent.

E. Timer Adjustment: Multiple adjustable ranges, including 1 second to 60 seconds, unless otherwise shown.

F. Manufacturers:

1. Omron.
2. Eaton.
3. General Electric Co.

2.12 SUPPORT AND FRAMING CHANNELS

A. Fiber Reinforced Plastic Channel:

1. Channel Size: 1-1/2-inch wide, minimum, FRP.
2. Members and Connections: Design for loads using one-half of manufacturer's allowable loads.
3. Fasteners: Vinyl ester fiber, polyurethane base composite nuts and bolts, or encapsulated steel fasteners.

- B. Carbon Steel Channel:
 - 1. Material: Rolled, mild strip steel, 12-gauge, ASTM A1011/A1011M, Grade 33.
 - 2. Finish: Hot-dip galvanized after fabrication.
- C. Stainless Steel Framing Channel: Rolled, ASTM A167, Type 316 stainless steel, 12-gauge.
- D. Extruded Aluminum Framing Channel:
 - 1. Material: Extruded from Type 6063 T6 aluminum alloy.
 - 2. Fittings fabricated from Alloy 5052 H32.
- E. Manufacturers:
 - 1. B-Line Systems, Inc.
 - 2. Unistrut Corp.
 - 3. Aickinstrut (FRP System).
 - 4. Enduro-Durostrut (FRP Systems).

2.13 NAMEPLATES

- A. Material: Laminated plastic.
- B. Attachment: Adhesive.
- C. Color: Black, engraved to a white core, or as shown.
- D. Engraving:
 - 1. Devices and Equipment: Name or tag shown, or as required.
 - 2. Panelboards:
 - a. Designation.
 - b. Service voltage.
 - c. Phases.
 - 3. Minimum Requirement: Label metering and power distribution equipment, local control panels, junction boxes, motor controls, and transformers.
- E. Letter Height:
 - 1. Pushbuttons, Selector Switches, and Other Devices: 1/8 inch.
 - 2. Equipment and Panelboards: 1/4 inch.

2.14 LIGHTING AND POWER DISTRIBUTION PANELBOARD

- A. NEMA PB 1, NFPA 70, and UL 67.
- B. Panelboards and Circuit Breakers: Suitable for use with 75 degrees C wire at full NFPA 70, 75 degrees C ampacity.
- C. Short-Circuit Current Equipment Rating: Fully rated; series connected unacceptable.
- D. Rating: Applicable to a system with available short-circuit current of 18,000 at 208Y/120 or 120/240 volts.
- E. Cabinet:
 - 1. NEMA 250, Type [1] [3R] [12].
 - 2. Material: Code-gauge, hot-dip galvanized sheet steel with reinforced steel frame.
 - 3. Wiring Gutter: Minimum 4 inch square; both sides, top and bottom.
 - 4. Front: Fastened with adjustable clamps.
 - a. Trim Size: As required by mounting.
 - b. Finish: Manufacturer's standard.
 - 5. Interior:
 - a. Factory assembled; complete with circuit breakers.
 - b. Spaces: Cover openings with easily removable metal cover.
 - 6. Door Hinges: Concealed.
 - 7. Locking Device:
 - a. Flush type.
 - b. Doors Over 30 Inches in Height: Multipoint.
 - 8. Circuit Directory: Metal frame with transparent plastic face and enclosed card on interior of door.
- F. Bus Bar:
 - 1. Material: Copper full sized throughout length.
 - 2. Neutral: Insulated, rated same as phase bus bars with at least one terminal screw for each branch circuit.
 - 3. Ground: Copper, installed on panelboard frame, bonded to box with at least one terminal screw for each circuit.
 - 4. Lugs and Connection Points:
 - a. Suitable for either copper or aluminum conductors.
 - b. Solderless main lugs for main, neutral, and ground bus bars.
 - c. Subfeed or through-feed lugs as shown.

G. Circuit Breakers:

1. UL 489.
2. Thermal-magnetic, quick-make, quick-break, molded case, of indicating type showing ON/OFF and TRIPPED positions of operating handle.
3. Type: Bolt-on circuit breakers in all panelboards.

H. Multipole circuit breakers designed to automatically open all poles when an overload occurs on one pole.

I. Do not use tandem or dual circuit breakers in normal single-pole spaces.

J. 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).

K. Manufacturers:

1. Eaton.
2. General Electric Co.
3. Square D Co.

2.15 CONDUIT AND FITTINGS

A. Rigid Galvanized Steel Conduit (RGS):

1. Meet requirements of NEMA C80.1 and UL 6.
2. Material: Hot-dip galvanized, with chromated protective layer.

B. PVC Schedule 40 Conduit:

1. Meet requirements of NEMA TC 2 and UL 651.
2. UL listed for concrete encasement, underground direct burial, concealed, or direct sunlight exposure, and 90 degrees C insulated conductors.

C. PVC-Coated Rigid Galvanized Steel Conduit:

1. Meet requirements of NEMA RN 1.
2. Material:
 - a. Meet requirements of NEMA C80.1 and UL 6.
 - b. Exterior Finish: PVC coating, 40 mils nominal thickness, bond to metal shall have tensile strength greater than PVC.
 - c. Interior Finish: Urethane coating, 2 mils nominal thickness.
3. Threads: Hot-dipped galvanized and factory coated with urethane.
4. Bendable without damage to either interior or exterior coating.

D. Flexible Metal, Liquid-Tight Conduit:

1. UL 360 listed for 105 degrees C insulated conductors.
2. Material: Galvanized steel, with an extruded PVC jacket.

E. Fittings:

1. Provide bushings, grounding bushings, conduit hubs, conduit bodies, couplings, unions, conduit sealing fittings, drain seals, drain/breather fittings, expansion fittings, and cable sealing fittings, as applicable.
2. Rigid Galvanized Steel and Intermediate Metal Conduit:
 - a. Meet requirements of UL 514B.
 - b. Type: Threaded, galvanized.
3. PVC Conduit:
 - a. Meet requirements of NEMA TC 3.
 - b. Type: PVC, slip-on.
4. PVC-Coated Rigid Galvanized Steel Conduit:
 - a. Meet requirements of UL 514B.
 - b. Fittings: Rigid galvanized steel type, PVC-coated by conduit manufacturer.
 - c. Conduit Bodies: Cast metal hot-dipped galvanized or urethane finish. Cover shall be of same material as conduit body. PVC-coated by conduit manufacturer.
 - d. Finish: 40-mil PVC exterior, 2-mil urethane interior.
 - e. Overlapping pressure sealing sleeves.
 - f. Conduit Hangers, Attachments, and Accessories: PVC-coated.
 - g. Manufacturers:
 - 1) Robroy Industries.
 - 2) Ocal.
 - h. Expansion Fitting Manufacturer and Product: Ocal; Ocal-Blue XJG.
5. Flexible Metal, Liquid-Tight Conduit:
 - a. Metal insulated throat connectors with integral nylon or plastic bushing rated for 105 degrees C.
 - b. Insulated throat and sealing O-rings.

2.16 CONDUIT ACCESSORIES

A. Duct Bank Spacers:

1. Type: Nonmetallic, interlocking, for multiple conduit sizes.
2. Suitable for all types of conduit.
3. Manufacturers:
 - a. Underground Device, Inc.
 - b. Carlon.

B. Identification Devices:

1. Raceway Tags:
 - a. Material: Permanent, nylon.
 - 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.

C. Raceway Band:

1. Slip-on Type:
 - a. Provide heat-shrinkable, black, medium-wall polyolefin tubing with factory-applied adhesive/sealant. Select product size based upon raceway outside diameter.
 - b. Manufacturer and Product: 3M; Type IMCSN, medium wall cable sleeve.
2. Wrap-around Type:
 - a. Provide 4-inch width, 20-mil thickness, nonprinted black PVC corrosion protection tape with primer.
 - b. Manufacturer and Product: 3M; Type Scotchrap 51 with Scotchrap Pipe Primer.

2.17 CONDUCTORS AND CABLES

A. Conductors 600 Volts and Below:

1. Conform to applicable requirements of NEMA WC 71, WC 72, and WC 74.
2. Conductor Type:
 - a. 120- and 277-Volt Lighting, No. 10 AWG and Smaller: Solid copper.
 - b. 120-Volt Receptacle Circuits, No. 10 AWG and Smaller: Solid copper.
 - c. All Other Circuits: Stranded copper.
3. Insulation: Type THHN/THWN.
4. Direct Burial and Aerial Conductors and Cables:
 - a. Type USE/RHH/RHW insulation, UL 854 listed or Type RHW-2/USE-2.

- b. Conform to physical and minimum thickness requirements of NEMA WC 70.
- 5. Flexible Cords and Cables:
 - a. Type SOW-A/50 with ethylene propylene rubber insulation in accordance with UL 62.
 - b. Conform to physical and minimum thickness requirements of NEMA WC 70.

B. 600-Volt Rated Cable:

- 1. General:
 - a. Type TC, meeting requirements of UL 1277, including Vertical Tray Flame Test at 20,000 Btu per hour, and NFPA 70, Article 340, or UL 13 meeting requirements of NFPA 70, Article 725.
 - b. Permanently and legibly marked with manufacturer's name, maximum working voltage for which cable was tested, type of cable, and UL listing mark.
 - c. Suitable for installation in open air, in cable trays, or conduit.
 - d. Minimum Temperature Rating: 90 degrees C dry locations, 75 degrees C wet locations.
 - e. Overall Outer Jacket: PVC, flame-retardant, sunlight- and oil-resistant.
- 2. Type 3, No. 16 AWG, Twisted, Shielded Pair, Instrumentation Cable: Single pair, designed for noise rejection for process control, computer, or data log applications meeting NEMA WC 55 requirements.
 - a. Outer Jacket: 45 mils nominal thickness.
 - b. Individual Pair Shield: 1.35 mils, double-faced aluminum/synthetic polymer overlapped to provide 100 percent coverage.
 - c. Dimension: 0.31-inch nominal outside diameter.
 - d. Conductors:
 - 1) Bare soft annealed copper, Class B, seven-strand concentric, meeting requirements of ASTM B8.
 - 2) 20 AWG, seven-strand tinned copper drain wire.
 - 3) Insulation: 15 mils nominal PVC.
 - 4) Jacket: 4 mils nominal nylon.
 - 5) Color Code: Pair conductors black and red.
 - e. Manufacturers: Okonite Co.
- 3. Type Cat5e, Unshielded Twisted Pair (UTP) Data Cable, 300V:
 - a. Category 6 UTP, UL listed, and third party verified to comply with TIA/EIA 568 C Category 6 requirements.
 - b. Suitable for high speed network applications including gigabit ethernet and video. Cable shall be interoperable with other standards compliant products and shall be backward compatible with Category 5 and Category 5e.

- c. Provide four each individually twisted pair, 23 AWG conductors, with FEP insulation and blue PVC jacket.
- d. NFPA 70 Plenum (CMP) rated; comply with flammability plenum requirements of NFPA 70 and NFPA 262.
- e. Cable shall withstand a bend radius of 1 inch minimum at a temperature of minus 20 degrees C maximum without jacket or insulation cracking.
- f. Manufacturer and Product: Belden; 7852A.

C. Accessories:

- 1. Tape:
 - a. General Purpose, Flame Retardant: 7 mils, vinyl plastic, Scotch Brand 33, rated for 90 degrees C minimum, meeting requirements of UL 510.
 - b. Flame Retardant, Cold and Weather Resistant: 8.5 mils, vinyl plastic, Scotch Brand 88.
 - c. Arc and Fireproofing:
 - 1) 30 mils, elastomer.
 - 2) Manufacturers and Products:
 - a) 3M; Scotch Brand 77, with Scotch Brand 69 glass cloth tapebinder.
 - b) Plymount; Plyarc 53, with Plyglas 77 glass cloth tapebinder.
- 2. Identification Devices:
 - a. Sleeve-type, permanent, PVC, yellow or white, with legible machine-printed black markings.
 - b. Manufacturer and Products: Raychem; Type D-SCE or ZH-SCE.
- 3. Connectors and Terminations:
 - a. Nylon, Self-Insulated Crimp Connectors:
 - 1) Manufacturers and Products:
 - a) Thomas & Betts; Sta-Kon.
 - b) Burndy; Insulug.
 - c) ILSCO.
- 4. Self-Insulated, Freespring Wire Connector (Wire Nuts):
 - a. Plated steel, square wire springs.
 - b. UL Standard 486C.
 - c. Manufacturers and Products:
 - 1) Thomas & Betts.
 - 2) Ideal; Twister.
- 5. Cable Lugs:
 - a. In accordance with NEMA CC 1.
 - b. Rated 600 volts of same material as conductor metal.
 - c. Uninsulated Crimp Connectors and Terminators:
 - 1) Suitable for use with 75 degrees C wire at full NFPA 70, 75 degrees C ampacity.

- 2) Manufacturers and Products:
 - a) Thomas & Betts; Color-Keyed.
 - b) Burndy; Hydent.
 - c) ILSCO.
- d. Uninsulated, Bolted, Two-Way Connectors and Terminators:
 - 1) Manufacturers and Products:
 - a) Thomas & Betts; Locktite.
 - b) Burndy; Quiklug.
 - c) ILSCO.
- 6. Cable Ties:
 - a. Nylon, adjustable, self-locking, and reusable.
 - b. Manufacturer and Product: Thomas & Betts; TY-RAP.
- 7. Heat Shrinkable Insulation:
 - a. Thermally stabilized, crosslinked polyolefin.
 - b. Manufacturer and Product: Thomas & Betts; SHRINK-KON.

2.18 MOTORS

A. Three-Phase:

- 1. For multiple units of the same type of equipment, furnish identical motors and accessories of a single manufacturer.
- 2. Meet requirements of NEMA MG 1.
- 3. Provide motors for hazardous (classified) locations that conform to UL 674 and have an applied UL listing mark.
- 4. Motors shall be specifically designed for use and conditions intended, with a NEMA design letter classification to fit application.
- 5. Lifting lugs on motors weighing 100 pounds or more.
- 6. Operating Conditions: Maximum ambient temperature not greater than 40 degrees C.
- 7. Horsepower Rating: As designated in motor-driven equipment specifications. Brake horsepower of the driven equipment at any operating condition shall not exceed motor nameplate horsepower rating, excluding any service factor.
- 8. Service Factor: 1.15 minimum at rated ambient temperature, unless otherwise shown.
- 9. Voltage and Frequency Rating: 460V ac, 60-Hz, unless otherwise indicated in motor-driven equipment specifications.
- 10. Suitable for full voltage starting. 100 hp and larger also suitable for reduced voltage starting with 65 or 80 percent voltage tap settings on reduced inrush motor starters.
- 11. Efficiency and Power Factor: Provide premium efficiency units, except for under 1 hp, multispeed, or short-time rated motors, or motors driving gates, valves, elevators, cranes, trolleys, and hoists. Provide standard power factor.

12. Insulation Systems: Unless otherwise indicated in motor-driven equipment specifications, Class B or Class F at nameplate horsepower and designated operating conditions.
13. Enclosures:
 - a. Open drip-proof, unless specified otherwise in the motor-driven equipment specification. Provide screens over air openings. Enclosures shall conform to NEMA MG 1.
 - b. TEFC and TENV: Furnish with a drain hole with porous drain/weather plug.
 - c. Equipment Finish: Manufacturer's standard.
14. Nameplates: In accordance with NEMA MG1.

B. Manufacturers:

1. General Electric.
2. Reliance Electric.
3. U.S. Electrical Motors.

2.19 GROUNDING

- A. Ground Rods: Provide copper-clad with minimum diameter of 5/8 inch, and length of 10 feet.
- B. Ground Conductors: As specified in Article Conductors and Cable.
- C. Connectors:
 1. Exothermic Weld Type:
 - a. Outdoor Weld: Suitable for exposure to elements or direct burial.
 - b. Indoor Weld: Utilize low-smoke, low-emission process.
 - c. Manufacturers:
 - 1) Erico Products, Inc.; Cadweld and Cadweld Exolon.
 - 2) Thermoweld.
 2. Compression Type:
 - a. Compress-deforming type; wrought copper extrusion material.
 - b. Single indentation for conductors 6 AWG and smaller.
 - c. Double indentation with extended barrel for conductors 4 AWG and larger.
 - d. Single barrels prefilled with oxide-inhibiting and antiseizing compound.
 - e. Manufacturers:
 - 1) Burndy Corp.
 - 2) Thomas and Betts Co.
 - 3) ILSCO.

3. Mechanical Type:
 - a. Split-bolt, saddle, or cone screw type; copper alloy material.
 - b. Manufacturers:
 - 1) Burndy Corp.
 - 2) Thomas and Betts Co.

PART 3 EXECUTION

3.01 GENERAL

- A. Install materials and equipment in accordance with manufacturer's instructions and recommendations.
- B. Work shall comply with all applicable provisions of NECA 1.
- C. Electrical Drawings show general locations of equipment, devices, and raceway, unless specifically dimensioned.

3.02 DEMOLITION

- A. General Demolition:
 1. Where shown, de-energize and disconnect nonelectrical equipment for removal by others.
 2. Where shown, de-energize, disconnect, and remove electrical equipment.
 3. Remove affected circuits and raceways back to serving panelboard or control panel. Where affected circuits are consolidated with others, remove raceways back to first shared conduit or box. Where underground or embedded raceways are to be abandoned, remove raceway to 1 inch below surface of structure or 12 inches belowgrade and restore existing surface.

3.03 PROTECTION FOLLOWING INSTALLATION

- A. Protect materials and equipment from corrosion, physical damage, and effects of moisture on insulation.
- B. Cap conduit runs during construction with manufactured seals.
- C. Close openings in boxes or equipment during construction.
- D. Energize space heaters furnished with equipment.

3.04 OUTLET AND DEVICE BOXES

- A. Install suitable for conditions encountered at each outlet or device in wiring or raceway system, sized to meet NFPA 70 requirements.

- B. Size:
 - 1. Depth: Minimum 2 inches, unless otherwise required by structural conditions. Box extensions not permitted.
 - a. Hollow Masonry Construction: Install with sufficient depth such that conduit knockouts or hubs are in masonry void space.
- C. Locations: Drawing locations are approximate.
- D. Mounting Height:
 - 1. General:
 - a. Dimensions given to centerline of box.
 - b. Where specified heights do not suit building construction or finish, mount as directed by Engineer.
- E. Install plumb and level.
- F. Flush Mounted:
 - 1. Install with concealed conduit.
 - 2. Install proper type extension rings or plaster covers to make edges of boxes flush with finished surface.
- G. Support boxes independently of conduit by attachment to building structure or structural member.
- H. Box Type (Steel Raceway System):
 - 1. Outdoor Locations: Cast metal.
 - 2. Indoor Locations:
 - a. Exposed Raceways: Cast metal.
 - b. Concealed Raceways: Cast metal.
 - 3. Cast-in-Place Concrete Slabs: Sheet steel.
- I. Box Type, Corrosive Locations (PVC-Coated rigid Galvanized Steel Raceway System): PVC-coated cast metal with matching cover.

3.05 JUNCTION AND PULL BOXES

- A. Install where shown and where necessary to terminate, tap-off, or redirect multiple conduit runs.
- B. Install pull boxes where necessary in raceway system to facilitate conductor installation.
- C. Install in conduit runs at least every 150 feet or after the equivalent of three right-angle bends.

- D. Use outlet boxes as junction and pull boxes wherever possible and allowed by applicable codes.
- E. Use conduit bodies as junction and pull boxes where no splices are required and their use is allowed by applicable codes.
- F. Installed boxes shall be accessible.
- G. Do not install on finished surfaces.
- H. Install plumb and level.
- I. Support boxes independently of conduit by attachment to building structure or structural member.
- J. At or Belowgrade:
 - 1. Install boxes for belowgrade conduit flush with finished grade in locations outside of paved areas, roadways, or walkways.
 - 2. If adjacent structure is available, box may be mounted on structure surface just above finished grade in accessible but unobtrusive location.
 - 3. Obtain Engineer's written acceptance prior to installation in paved areas, roadways, or walkways.
 - 4. Use boxes and covers suitable to support anticipated weights.
- K. Mounting Hardware: Stainless steel.
- L. Location/Type:
 - 1. Indoor, Dry: NEMA 250, Type 1.
 - 2. Indoor and Outdoor, Wet or Corrosive: NEMA 250, Type 4X, stainless steel.
 - 3. Underground Conduit: Concrete.
 - 4. Corrosive: NEMA 250, Type 4X, stainless steel.
 - 5. Industrial Use in Areas Not Otherwise Classified: NEMA 250, Type 12, unless otherwise shown.
- M. Install Drain/breather fittings in NEMA 250, Type 4 and Type 4X enclosures.

3.06 PRECAST HANDHOLES

- A. Excavate, shore, brace, backfill, and final grade in accordance with Section 31 23 16, Excavation, and Section 31 23 23.15, Trench Backfill.
- B. Do not install until final raceway grading has been determined.
- C. Install such that raceways enter at nearly right angles and as near as possible to one end of wall, unless otherwise shown.

3.07 PANELBOARDS

- A. Install securely, plumb, in-line and square with walls.
- B. Install top of cabinet 6 feet above floor, unless otherwise shown.
- C. Provide typewritten circuit directory for each panelboard.
- D. Cabinet Location/Type:
 - 1. Indoor Dry: NEMA 250, Type 1.
 - 2. Wet or Outdoor: NEMA 250, Type 3R, Outdoor.
 - 3. Industrial Use in Areas Not Otherwise Classified: NEMA 250, Type 12, unless otherwise shown.

3.08 CIRCUIT BREAKERS AND SWITCHES

- A. Location and Enclosure Type:
 - 1. Wet or Outdoor: NEMA 250, Type 4.
 - 2. Corrosive: NEMA 250, Type 4X.
 - 3. Wet and Corrosive: NEMA 250, Type 4X.
 - 4. Indoor Dry, Industrial Use: NEMA 250, Type 12.
 - 5. Indoor Dry, General Purpose: NEMA 250, Type 1.
 - 6. Where Denoted WP: NEMA 250, Type 3R.

3.09 SWITCH, MOTOR RATED

- A. Install with switch operation in vertical position such that toggle is in up position when ON.
- B. Install within sight of motor when used as a disconnect switch.
- C. Mounting Height: See Article Outlet and Device Boxes.
- D. Enclosure Type:
 - 1. General Purpose: See Articles Outlet and Device Boxes and Device Plates.
 - 2. Explosion-proof: See product specification.

3.10 TERMINAL BLOCKS

- A. Install for termination of control circuits entering or leaving equipment and local control panels.

3.11 SUPPORT AND FRAMING CHANNELS

- A. Install where required for mounting and supporting electrical equipment and raceway systems.
- B. Channel Type:
 - 1. Interior, Wet or Dry Noncorrosive Locations: Hot-dip Galvanized Carbon steel.
 - 2. Interior, Wet or Dry Corrosive Locations: Type 316 stainless steel.
 - 3. Outdoor, Noncorrosive Locations: Hot-dip Galvanized Carbon steel.
 - 4. Outdoor, Corrosive Locations: Type 316 stainless steel.
 - 5. Liquid Lime Containment: FRP.
- C. Paint carbon steel channel cut ends prior to installation with zinc-rich primer.

3.12 NAMEPLATES

- A. Provide identifying nameplate on all equipment.

3.13 CONDUIT AND FITTINGS

- A. General:
 - 1. Crushed or deformed raceways not permitted.
 - 2. Maintain raceway entirely free of obstructions and moisture.
 - 3. Immediately after installation, plug or cap raceway ends with watertight and dust-tight seals until time for pulling in conductors.
 - 4. Sealing Fittings: Provide drain seal in vertical raceways where condensate may collect above sealing fitting.
 - 5. Avoid moisture traps where possible. When unavoidable in exposed conduit runs, provide junction box and drain fitting at conduit low point.
 - 6. Group raceways installed in same area.
 - 7. Follow structural surface contours when installing exposed raceways. Avoid obstruction of passageways.
 - 8. Run exposed raceways parallel or perpendicular to walls, structural members, or intersections of vertical planes.
 - 9. Block Walls: Do not install raceways in same horizontal course with reinforcing steel.
 - 10. Install watertight fittings in outdoor, underground, or wet locations.
 - 11. Paint threads and cut ends, before assembly of fittings, galvanized conduit, or PVC-coated galvanized conduit, installed in exposed or damp locations with zinc-rich paint or liquid galvanizing compound.
 - 12. Metal conduit to be reamed, burrs removed, and cleaned before installation of conductors, wires, or cables.
 - 13. Do not install raceways in concrete equipment pads, foundations, or beams.

14. Horizontal raceways installed under floor slabs shall lie completely under slab, with no part embedded within slab.
15. Install concealed, embedded, and buried raceways so that they emerge at right angles to surface and have no curved portion exposed.
16. Install conduits for fiber optic cables, telephone cables, and Category 5 data cables in strict conformance with the requirements of EIA/TIA 569.

B. Installation in Cast-in-Place Structural Concrete:

1. Minimum cover 2 inches, including all fittings.
2. Conduit placement shall not require changes in reinforcing steel location or configuration.
3. Provide nonmetallic support during placement of concrete to ensure raceways remain in position.
4. Conduit larger than 1 inch shall not be embedded in concrete slabs, walls, foundations, columns or beams, unless approved by Engineer.
5. Slabs and Walls:
 - a. Trade size of conduit not to exceed one-fourth of the slab or wall thickness.
 - b. Install within middle two-fourths of slab or wall.
 - c. Separate conduit less than 2-inch trade size by a minimum ten times conduit trade size, center-to-center, unless otherwise shown.
 - d. Separate conduit 2 inches and greater trade size by a minimum eight times conduit trade size, center-to-center, unless otherwise shown.
 - e. Cross conduit at an angle greater than 45 degrees, with minimum separation of 1 inch.
 - f. Separate conduit by a minimum six times the outside dimension of expansion and deflection fittings at expansion joints.
 - g. Conduit shall not be installed below the maximum water surface elevation in walls of water holding structures.
6. Columns and Beams:
 - a. Trade size of conduit not to exceed one-fourth of beam thickness.
 - b. Conduit cross-sectional area not to exceed 4 percent of beam or column cross section.

C. Conduit Application:

1. Diameter: Minimum 3/4-inch.
2. Outdoor, Exposed: PVC-coated rigid galvanized steel.
3. Indoor, Non-Corrosive, Exposed: Rigid galvanized steel.
4. Direct Earth Burial: PVC-coated rigid galvanized steel.
5. Under Slabs-On-Grade: PVC-coated rigid galvanized steel.
6. Corrosive Areas: PVC-coated rigid galvanized steel.

D. Connections:

1. For motors-, wall-, or ceiling-mounted fans and unit heaters, dry type transformers, electrically operated valves, instrumentation, and other equipment where flexible connection is required to minimize vibration:
 - a. General: Flexible metal, liquid-tight conduit.
 - b. Wet or Corrosive Areas: Flexible metal liquid-tight.
 - c. Length: 18 inches minimum, 60 inches maximum, sufficient to allow movement or adjustment of equipment.
2. Outdoor areas, process areas exposed to moisture, and areas required to be oiltight and dust-tight: Flexible metal, liquid-tight conduit.
3. Transition From Underground or Concrete Embedded to Exposed: PVC-coated rigid steel conduit.
4. Under Equipment Mounting Pads: PVC-coated rigid steel conduit.

E. Penetrations:

1. Make at right angles, unless otherwise shown.
2. Notching or penetration of structural members, including footings and beams, not permitted.
3. Fire-Rated Walls, Floors, or Ceilings: Firestop openings around penetrations to maintain fire-resistance rating using fire penetration seal.
4. Concrete Walls, Floors, or Ceilings (Aboveground): Provide nonshrink grout dry-pack.
5. Entering Structures:
 - a. General: Seal raceway at the first box or outlet with oakum or expandable plastic compound to prevent the entrance of gases or liquids from one area to another.
 - b. Concrete Roof or Membrane Waterproofed Wall or Floor: Provide watertight seal.
 - c. Heating, Ventilating, and Air Conditioning Equipment:
 - 1) Penetrate equipment in area established by manufacturer.
 - 2) Terminate conduit with flexible metal conduit at junction box or conduit attached to exterior surface of equipment prior to penetrating equipment.
 - 3) Seal penetration with Type 5 sealant joint sealants.
 - d. Corrosive-Sensitive Areas:
 - 1) Seal all conduit passing through chlorine and ammonia room walls.
 - 2) Seal conduit entering equipment panelboards and field panels containing electronic equipment.
 - 3) Seal penetration with Type 5 sealant joint sealants.
 - e. Existing or Precast Wall (Underground): Core drill wall and install watertight entrance seal device.

- f. Nonwaterproofed Wall or Floor (Underground, without Concrete Encasement):
 - 1) Provide Schedule 40 galvanized pipe sleeve or watertight entrance seal device.
 - 2) Fill space between raceway and sleeve with expandable plastic compound or oakum and lead joint on each side.
- g. Handholes:
 - 1) Metallic Raceways: Provide insulated grounding bushings.
 - 2) Nonmetallic Raceways: Provide bell ends flush with wall.

F. Support:

- 1. Support from structural members only, at intervals not exceeding NFPA 70 requirements, and in any case not exceeding 8 feet. Do not support from piping, pipe supports, or other raceways.
- 2. Multiple Adjacent Raceways: Provide ceiling trapeze.
- 3. Application/Type of Conduit Strap:
 - a. Steel Conduit: Zinc-coated steel, pregalvanized steel, or malleable iron.
 - b. PVC-Coated Rigid Steel Conduit: PVC-coated metal.
 - c. Nonmetallic Conduit: Nonmetallic or PVC-coated metal.
- 4. Provide and attach wall brackets, strap hangers, or ceiling trapeze as follows:
 - a. Wood: Wood screws.
 - b. Hollow Masonry Units: Toggle bolts.
 - c. Concrete or Brick: Expansion shields, or threaded studs driven in by powder charge, with lock washers and nuts.
 - d. Steelwork: Machine screws.
 - e. Location/Type of Hardware:
 - 1) Dry, Noncorrosive Areas: Galvanized.
 - 2) Wet, Noncorrosive Areas: Stainless steel.
 - 3) Corrosive Areas: Stainless steel.

G. Bends:

- 1. Install concealed raceways with a minimum of bends in the shortest practical distance.
- 2. Make bends and offsets of longest practical radius. Bends in conduits and ducts being installed for fiber optic cables shall be not less than 20 times cable diameter, 15 inches minimum.
- 3. Install with symmetrical bends or cast metal fittings.
- 4. Avoid field-made bends and offsets, but where necessary, make with acceptable hickey or bending machine. Do not heat metal raceways to facilitate bending.
- 5. Make bends in parallel or banked runs from same center or centerline with same radius so that bends are parallel.

6. Factory elbows may be installed in parallel or banked raceways if there is change in plane of run and raceways are same size.
 7. PVC Conduit:
 - a. Bends 30 Degrees and Larger: Provide factory-made elbows.
 - b. 90-Degree Bends: Provide rigid steel elbows, PVC coated where direct buried.
 - c. Use manufacturer's recommended method for forming smaller bends.
 8. Flexible Conduit: Do not make bends that exceed allowable conductor bending radius of cable to be installed or that significantly restricts conduit flexibility.
- H. Expansion and Deflection Fittings: Provide on all raceways at structural expansion joints and in long tangential runs.
- I. PVC Conduit:
1. Solvent Welding:
 - a. Provide manufacturer recommended solvent; apply to all joints.
 - b. Install such that joint is watertight.
 2. Adapters:
 - a. PVC to Metallic Fittings: PVC terminal type.
 - b. PVC to Rigid Metal Conduit: PVC female adapter.
 3. Belled-End Conduit: Bevel the unbelled end of the joint prior to joining.
- J. PVC-Coated Rigid Steel Conduit:
1. Install in accordance with manufacturer's instructions.
 2. All tools and equipment used in the cutting, bending, threading, and installation of PVC-coated rigid steel conduit shall be designed to limit damage to the PVC coating.
 3. Provide PVC boot to cover all exposed threading.
- K. Termination at Enclosures:
1. Cast Metal Enclosure: Provide manufacturer's premolded insulating sleeve inside metallic conduit terminating in threaded hubs.
 2. Nonmetallic, Cabinets, and Enclosures: Terminate conduit in threaded conduit hubs, maintaining enclosure integrity.
 3. Sheet Metal Boxes, Cabinets, and Enclosures:
 - a. Rigid Galvanized Conduit:
 - 1) Provide one lock nut each on inside and outside of enclosure.
 - 2) Install grounding bushing.

- 3) Provide bonding jumper from grounding bushing to equipment ground bus or ground pad; if neither ground bus nor pad exists, connect jumper to lag bolt attached to metal enclosure.
- 4) Install insulated bushing on ends of conduit where grounding is not required.
- 5) Provide insulated throat when conduit terminates in sheet metal boxes having threaded hubs.
- 6) Use sealing locknuts or threaded hubs on outside of NEMA 3R and NEMA 12 enclosures.
- 7) Terminate conduits with threaded conduit hubs at NEMA 4 and 4X boxes and enclosures.
- b. Flexible Metal Conduit: Provide two-screw type, insulated, malleable iron connectors.
- c. PVC-coated Rigid Galvanized Steel Conduit: Provide PVC-coated, liquid-tight, metallic connector.
- d. PVC Schedule 40 Conduit: Provide PVC terminal adapter with locknut.
4. Free-Standing Enclosures:
 - a. Terminate metal conduit entering bottom with grounding bushing; provide a grounding jumper extending to equipment ground bus or grounding pad.
 - b. Terminate PVC conduit entering bottom with bell end fittings.

L. Underground Raceways:

1. Grade: Maintain minimum grade of 4 inches in 100 feet, either from one manhole, handhole, or pull box to the next, or from a high point between them, depending on surface contour.
2. Cover: Maintain minimum 2-foot cover above conduit, unless otherwise shown.
3. Make routing changes as necessary to avoid obstructions or conflicts.
4. Couplings: In multiple conduit runs, stagger so couplings in adjacent runs are not in same transverse line.
5. Union type fittings not permitted.
6. Spacers:
 - a. Provide preformed, nonmetallic spacers, designed for such purpose, to secure and separate parallel conduit runs in a trench.
 - b. Install at intervals not greater than that specified in NFPA 70 for support of the type conduit used, but in no case greater than 10 feet.
7. Support conduit so as to prevent bending or displacement during backfilling.
8. Installation with Other Piping Systems:
 - a. Crossings: Maintain minimum 12-inch vertical separation.
 - b. Parallel Runs: Maintain minimum 12-inch separation.

- c. Installation over valves or couplings not permitted.
- 9. Metallic Raceway Coating: Along entire length, coat with raceway coating.
- 10. Provide expansion fittings that allow minimum of 4 inches of movement in vertical conduit runs from underground where exposed conduit will be fastened to or will enter building or structure.
- 11. Provide deflectional/expansion fittings in conduit runs that exit building or structure belowgrade. Conduit from building wall to fitting shall be PVC-coated rigid steel.
- 12. Backfill:
 - a. As specified in Section 31 23 23.15, Trench Backfill.
 - b. Do not backfill until inspected by Engineer.

M. Empty Raceways:

- 1. Provide permanent, removable cap over each end.
- 2. Provide PVC plug with pull tab for underground raceways with end bells.
- 3. Provide nylon pull cord.
- 4. Identify, as specified in Article Identification Devices, with waterproof tags attached to pull cord at each end, and at intermediate pull point.

N. Identification Devices:

- 1. Warning Tape: Install approximately 12 inches above underground or concrete-encased raceways. Align parallel to, and within 12 inches of, centerline of runs.

O. Raceway Band:

- 1. Install wherever metallic conduit emerges from concrete slabs. Not required with PVC-coated RGS conduit. Center band at slab surface and install according to manufacturer's instructions.
 - a. Slip-on Type: Clean conduit surface at installation location. Cut tubing to 4-inch minimum lengths and slip onto raceway prior to slab placement and termination of conduit. Heat-shrink onto conduit.
 - b. Wrap-around Type: Use where slip-on access to conduit is not possible. Clean conduit surface at installation location. Apply primer. Apply wraps to provide two layers of tape. Neatly finish tape end to prevent unraveling.

3.14 CONDUCTORS AND CABLES

- A. Conductor storage, handling, and installation shall be in accordance with manufacturer's recommendations.

- B. Do not exceed manufacturer's recommendations for maximum pulling tensions and minimum bending radii.
- C. Conduit system shall be complete prior to drawing conductors. Lubricate prior to pulling into conduit. Lubrication type shall be as approved by conductor manufacturer.
- D. Terminate all conductors and cables, unless otherwise shown.
- E. Do not splice conductors, unless specifically indicated or approved by Engineer.
- F. Bundling: Where single conductors and cables in manholes, handholes, vaults, cable trays, and other indicated locations are not wrapped together by some other means, bundle conductors from each conduit throughout their exposed length with cable ties placed at intervals not exceeding 12 inches.
- G. Wiring within Equipment and Local Control Panels: Remove surplus wire, dress, bundle, and secure.
- H. Power Conductor Color Coding:
 - 1. No. 6 AWG and Larger: Apply general purpose, flame retardant tape at each end, and at accessible locations wrapped at least six full overlapping turns, covering an area 1-1/2 to 2 inches wide.
 - 2. No. 8 AWG and Smaller: Provide colored conductors.
 - 3. Colors:
 - a. Neutral Wire: White.
 - b. Live Wires, 120/240-Volt, Single-Phase System: Black, red.
 - c. Live Wires, 120/208-Volt, Three-Phase System: Black, red, or blue.
 - d. Live Wires, 277/480-Volt, Three-Phase System: Brown, orange, or yellow.
 - e. Ground Wire: Green.
- I. Circuit Identification:
 - 1. Assign circuit name based on device or equipment at load end of circuit. Where this would result in same name being assigned to more than one circuit, add number or letter to each otherwise identical circuit name to make it unique.
 - 2. Method: Identify with sleeves. Taped-on markers or tags relying on adhesives not permitted.

J. Connections and Terminations:

1. Install wire nuts only on solid conductors.
2. Install nylon self-insulated crimp connectors and terminators for instrumentation and control circuit conductors.
3. Tape insulate all uninsulated connections.
4. Install crimp connectors and compression lugs with tools approved by connector manufacturer.

3.15 GROUNDING

- A. Grounding shall be in compliance with NFPA 70 and as shown.
- B. Ground electrical service neutral at service entrance equipment to supplementary grounding electrodes.
- C. Ground each separately derived system neutral to nearest effectively grounded building structural steel member or separate grounding electrode.
- D. Bond together system neutrals, service equipment enclosures, exposed noncurrent-carrying metal parts of electrical equipment, metal raceways, ground conductor in raceways and cables, receptacle ground connections, and metal piping systems.
- E. Shielded Instrumentation Cables:
1. Ground shield to ground bus at power supply for analog signal.
 2. Expose shield minimum 1 inch at termination to field instrument and apply heat shrink tube.
 3. Do not ground instrumentation cable shield at more than one point.
- F. Equipment Grounding Conductors: Provide in all conduits containing power conductors and control circuits above 50 volts.
- G. Ground Rods: Install full length with conductor connection at upper end. Install one ground rod in each handhole.

3.16 FIELD QUALITY CONTROL

- A. Tests shall be performed in accordance with the requirements of Section 01 91 14, Equipment Testing and Facility Startup.
- B. General:
1. Test equipment shall have an operating accuracy equal to, or greater than, requirements established by NETA ATS.
 2. Test instrument calibration shall be in accordance with NETA ATS.

3. Perform inspection and electrical tests after equipment has been installed.
 4. Perform tests with apparatus de-energized whenever feasible.
 5. Inspection and electrical tests on energized equipment are to be:
 - a. Scheduled with Engineer prior to de-energization.
 - b. Minimized to avoid extended period of interruption to the operating plant equipment.
- C. Tests and inspection shall establish that:
1. Electrical equipment is operational within industry and manufacturer's tolerances.
 2. Installation operates properly.
 3. Equipment is suitable for energization.
 4. Installation conforms to requirements of Contract Documents and NFPA 70.
- D. Perform inspection and testing in accordance with NETA ATS, industry standards, and manufacturer's recommendations.
- E. Adjust mechanisms and moving parts for free mechanical movement.
- F. Adjust adjustable relays and sensors to correspond to operating conditions, or as recommended by manufacturer.
- G. Verify nameplate data for conformance to Contract Documents.
- H. Realign equipment not properly aligned and correct unlevelness.
- I. Properly anchor electrical equipment found to be inadequately anchored.
- J. Tighten accessible bolted connections, including wiring connections, with calibrated torque wrench to manufacturer's recommendations, or as otherwise specified.
- K. Clean contaminated surfaces with cleaning solvents as recommended by manufacturer.
- L. Provide proper lubrication of applicable moving parts.
- M. Investigate and repair or replace:
1. Electrical items that fail tests.
 2. Active components not operating in accordance with manufacturer's instructions.
 3. Damaged electrical equipment.

N. Electrical Enclosures:

1. Remove foreign material and moisture from enclosure interior.
2. Vacuum and wipe clean enclosure interior.
3. Remove corrosion found on metal surfaces.
4. Repair or replace, as determined by Engineer, door and panel sections having damaged surfaces.
5. Replace missing or damaged hardware.

O. Provide certified test report(s) documenting the successful completion of specified testing. Include field test measurement data.

P. Test the following equipment and materials:

1. Conductors: Insulation resistance, No. 4 and larger only.
2. Panelboards, switches, and circuit breakers.
3. Motor controls.
4. Grounding electrodes.
5. Motors.

Q. Controls:

1. Test control and signal wiring for proper termination and function.
2. Test local control panels and other control devices for proper terminations, configuration and settings, and functions.
3. Demonstrate control, monitoring, and indication functions in presence of Owner and Engineer.

END OF SECTION

SECTION 31 23 13 SUBGRADE PREPARATION

PART 1 GENERAL

1.01 REFERENCES

- A. The following is a list of standards which may be referenced in this section:
 - 1. ASTM International (ASTM):
 - a. D698, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lb/ft³ (600 kN-m/m³)).
 - b. D1557, Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft³ (2,700 kN-m/m³)).

1.02 DEFINITIONS

- A. Optimum Moisture Content: As defined in Section 31 23 23, Fill and Backfill.
- B. Prepared Ground Surface: Ground surface after completion of clearing and grubbing, scalping of sod, stripping of topsoil, excavation to grade, and scarification and compaction of subgrade.
- C. Relative Compaction: As defined in Section 31 23 23, Fill and Backfill.
- D. Relative Density: As defined in Section 31 23 23, Fill and Backfill.
- E. Subgrade: Layer of existing soil after completion of clearing, grubbing, scalping of topsoil prior to placement of fill, roadway structure or base for floor slab.
- F. Proof-Rolling: Testing of subgrade by compactive effort to identify areas that will not support the future loading without excessive settlement.

1.03 SEQUENCING AND SCHEDULING

- A. Complete applicable 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: Three 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. Clearing, Grubbing, and Stripping: Complete applicable Work specified in Section 31 10 00, Site Clearing, prior to excavating.

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.

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 as specified in Section 31 10 00, Site Clearing, for clearing and grubbing debris.

END OF SECTION

SECTION 31 23 23 FILL AND BACKFILL

PART 1 GENERAL

1.01 REFERENCES

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

1. ASTM International (ASTM):
 - a. C117, Standard Test Method for Materials Finer Than 75-Micrometers (No. 200) Sieve in Mineral Aggregates by Washing.
 - b. C136, Standard Method for Sieve Analysis of Fine and Coarse Aggregates.
 - c. D75, Standard Practice for Sampling Aggregates.
 - d. D698, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft³ (600 kN-m/m³)).
 - e. D1556, Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method.
 - f. D1557, Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft³ (2,700 kN-m/m³)).
 - g. D4253, Standard Test Methods for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table.
 - h. D4254, Standard Test Method for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density.
 - i. D6938, Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).

1.02 DEFINITIONS

A. Relative Compaction:

1. Ratio, in percent, of as-compacted field dry density to laboratory maximum dry density as determined in accordance with ASTM 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 current edition of the Georgia Department of Transportation Standard Specifications.

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 GRANULAR FILL

- A. 1-inch minus crushed gravel or crushed rock.
- B. Free from dirt, clay balls, and organic material.
- C. Well-graded from coarse to fine and containing sufficient fines to bind material when compacted, but with maximum 8 percent by weight passing No. 200 sieve.

2.04 SAND

- A. Free from clay, organic matter, or other deleterious material.
- B. Gradation as determined in accordance with ASTM C117 and ASTM C136:

| <u>Sieve Size</u> | <u>Percent Passing by Weight</u> |
|-------------------|----------------------------------|
| 1/4-inch | 100 |
| No. 4 | 95 - 100 |
| No. 200 | 0 - 8 |

2.05 WATER FOR MOISTURE CONDITIONING

- A. Free of hazardous or toxic contaminates, or contaminants deleterious to proper compaction.

2.06 BASE COURSE ROCK

- A. As specified in for Group I Aggregates in Section 815 of the GDOT Standard Specifications.

2.07 FOUNDATION STABILIZATION ROCK

- A. Crushed rock or pit run rock.
- B. Uniformly graded from coarse to fine.
- C. Free from excessive dirt and other organic material.
- D. Maximum 2-1/2-inch particle size.

PART 3 EXECUTION

3.01 GENERAL

- A. Keep placement surfaces free of water, debris, and foreign material during placement and compaction of fill and backfill materials.
- B. Place and spread fill and backfill materials in horizontal lifts of uniform thickness, in a manner that avoids segregation, and compact each lift to specified densities prior to placing succeeding lifts. Slope lifts only where necessary to conform to final grades or as necessary to keep placement surfaces drained of water.
- C. During filling and backfilling, keep level of fill and backfill around each structure and buried tank even.
- D. Do not place fill or backfill, if fill or backfill material is frozen, or if surface upon which fill or backfill is to be placed is frozen.
- E. If pipe, conduit, duct bank, or cable is to be laid within fill or backfill:
 - 1. Fill or backfill to an elevation 2 feet above top of item to be laid.
 - 2. Excavate trench for installation of item.
 - 3. Install bedding, if applicable, as specified in Section 31 23 23.15, Trench Backfill.
 - 4. Install item.
 - 5. Backfill envelope zone and remaining trench, as specified in Section 31 23 23.15, Trench Backfill, before resuming filling or backfilling specified in this section.
- F. Tolerances:
 - 1. Final Lines and Grades: Within a tolerance of 0.1 foot unless dimensions or grades are shown or specified otherwise.
 - 2. Grade to establish and maintain slopes and drainage as shown. Reverse slopes are not permitted.
- G. Settlement: Correct and repair any subsequent damage to structures, pavements, curbs, slabs, piping, and other facilities, caused by settlement of fill or backfill material.

3.02 BACKFILL UNDER AND AROUND STRUCTURES

- A. Under Facilities: Within influence area beneath structures, slabs, pavements, curbs, piping, conduits, duct banks, and other facilities, backfill with granular fill, unless otherwise shown. Place granular fill in lifts of 6-inch maximum

thickness and compact each lift to minimum of 95 percent relative compaction as determined in accordance with ASTM 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.

3.03 FILL

- A. Outside Influence Areas beneath Structures, Tanks, Pavements, Curbs, Slabs, Piping, and Other Facilities: Unless otherwise shown, place earthfill as follows:
 - 1. Allow for 6-inch thickness of topsoil where required.
 - 2. Maximum 8-inch thick lifts.
 - 3. Place and compact fill across full width of embankment.
 - 4. Dress completed embankment with allowance for topsoil, crest surfacing, and slope protection, where applicable.

3.04 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. Granular Fill: One test per lift minimum, per 2,000 square feet of area.
 - 2. Sand: One test per lift minimum, per 2,000 square feet of area.
 - 3. Base Course Rock: One test per lift minimum, per 2,000 square feet of area.

3.05 SAND BLANKET OVER VAPOR RETARDER

- A. Place sand in manner that avoids damage to underlying vapor retarder.
- B. Moisten sand and thoroughly compact it with a vibratory plate compactor.

3.06 GRANULAR BASE, SUBBASE, AND SURFACING

- A. Place and compact as specified in Standard Specifications.

3.07 REPLACING OVEREXCAVATED MATERIAL

- A. Replace excavation carried below grade lines shown or established by Engineer as follows:
1. Beneath Footings: Granular fill.
 2. Beneath Fill or Backfill: Same material as specified for overlying fill or backfill.
 3. Beneath Slabs-On-Grade: Granular fill.
 4. Trenches:
 - a. Unauthorized Overexcavation: Either trench stabilization material or granular pipe base material, as specified in Section 31 23 23.15, Trench Backfill.
 - b. Authorized Overexcavation: Trench stabilization material, as specified in Section 31 23 23.15, Trench Backfill.
 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. Granular Fill 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. As specified in Section 32 91 13, Soil Preparation.

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 33 05 16.13
PRECAST CONCRETE UTILITY STRUCTURE

PART 1 GENERAL

1.01 REFERENCES

- A. The following is a list of standards that may be referenced in this section:
1. American Association of State Highway and Transportation Officials (AASHTO): HB-17, Standard Specifications for Highway Bridges, Division 1 Section 3, Division I Design-Loads (Part A, Part B, Part C).
 2. ASTM International (ASTM):
 - a. A497/A497M, Standard Specification for Steel Welded Wire Reinforcement, Deformed, for Concrete.
 - b. A615/A615M, Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
 - c. C387/C387M, Standard Specification for Packaged, Dry, Combined Materials for Mortar and Concrete.
 - d. C478, Standard Specification for Precast Reinforced Concrete Manhole Sections.
 - e. C857, Standard Practice for Minimum Structural Design Loading for Underground Precast Concrete Utility Structures.
 - f. C858, Standard Specification for Underground Precast Concrete Utility Structures.
 - g. D4101, Standard Specification for Propylene Injection and Extrusion Materials.
 3. Occupational Safety and Health Administration (OSHA):
 - a. 29 CFR 1910.27, Fixed Ladders.
 - b. 29 CFR 1926.502, Fall Protection Systems Criteria and Practices.

1.02 SUBMITTALS

- A. Action Submittals:
1. Shop Drawings:
 - a. Detailed Drawings showing complete information for fabrication including, but not limited to:
 - 1) Member dimensions and cross sections; location, size, and type of reinforcement, including additional reinforcement.
 - 2) Layout dimensions and identification of each precast unit.
 - 3) Welded connections indicated by AWS standard symbols.
 - 4) Details of connections, joints, accessories, and openings or inserts.
 - 5) Watertight joint details.

- 6) Location and details of anchorage devices.
- 7) Access door details.
- 8) Details of polypropylene steps.
- b. Product Data:
 - 1) Precast concrete items; show materials of construction by ASTM reference and grade.
 - 2) Joint sealants.

B. Informational Submittals:

1. Manufacturer's data for lifting devices for handling and erection.
2. Manufacturer's certification that vault design and manufacture comply with referenced ASTMs (for example, ASTM C857 and ASTM C858).
3. Vault design calculation shall be signed by a civil or structural engineer registered in the State of Georgia.
4. Certified load test data for polypropylene steps.

1.03 DELIVERY, STORAGE, AND HANDLING

- A. Store each unit in a manner that will prevent cracking, distortion, warping, straining and other physical damage, and in a manner to keep marking visible.
- B. Lift and support each unit only at designated lifting points and supporting points as shown on Shop Drawings.

PART 2 PRODUCTS

2.01 VAULT MANUFACTURERS

- A. Materials, equipment, and accessories specified in this section shall be products of:
 1. Oldcastle Precast.
 2. Jensen Precast.
 3. Hanson Pipe and Precast.

2.02 PRECAST CONCRETE VAULTS

- A. Design Requirements:
 1. In the event of a conflict between or among standards, the more stringent standard shall govern.
 2. Comply with ASTM C858, except as modified herein.
 3. Reinforcing Steel:
 - a. Deformed Bars: ASTM A615/A615M, Grade 60.
 - b. Welded Wire Fabric: ASTM A497/A497M.

4. Nominal Dimensions: As shown on Drawings.
 5. Construction: Rigid type and behave monolithically.
 6. Design Loads: As determined by ASTM C857, and by using Site-specific values shown below and as shown on the Structural General Notes on the Drawings:
 - a. Live Loads: AASHTO HS20-44 truck loading plus impact.
 - b. Designed to avoid flotation with a factor of safety equal to 1.2.
 7. Design shall accommodate additional stresses or loads that may be imposed during factory precasting, transporting, erection, and placement.
 8. Blockouts for penetrations shall be as shown on Drawings.
 9. Sealant:
 - a. Nonswelling preformed joint sealants to provide a lasting, watertight bond.
 - b. Manufacturer and Product: Henry Company; RAM-NEK.
 10. Mortar: Comply with ASTM C387/C387M, Type S or use Type I grout as specified in Section 03 62 00, Nonshrink Grouting.
- B. Mark each member or element to indicate location in the structure, top surface, and date of fabrication.

2.03 ACCESSORIES

- A. Polypropylene Steps:
1. Fabricate from minimum 1/2-inch, Grade 60, steel bar meeting ASTM A615/A615M.
 2. Polypropylene Encasement: Conform to ASTM D4101.
 3. Minimum Width: 13 inches, center-to-center of legs.
 4. Embedment: 3-1/2 inches minimum and 4-1/2-inch minimum projection from face of concrete at point of embedment to center of step.
 5. Cast in vault sections by manufacturer.
 6. Load Test: Capable of withstanding ASTM C478 vertical and horizontal load tests.
- B. Sidewalk Doors and Hatches: Manufacturer's standard HS-20 load rated, spring-assisted, lockable, galvanized steel access door, size as indicated on Drawings. Doors and hatches shall be provided with antislip coating.
- C. Pipe Connections to Vault: Grout conforming to requirements of Section 03 62 00, Nonshrink Grouting.

PART 3 EXECUTION

3.01 GENERAL

- A. Possible Settlement: If subgrade is encountered that may require removal to prevent structure settlement, notify Engineer. Engineer will determine depth of over excavation and means of stabilizing subgrade prior to structure installation.
- B. Place 12-inch minimum thickness of imported crushed aggregate material on undisturbed earth or modified subgrade; thoroughly compact with a mechanical vibrating or power tamper. Meet requirements of Article Excavation and Backfill.

3.02 EXCAVATION AND BACKFILL

- A. Remove and keep water clear from excavation during construction.
- B. Excavation: As specified in Section 31 23 16, Excavation.
- C. Backfill: As specified in Section 31 23 23, Fill and Backfill, and Section 31 23 23.15, Trench Backfill.

3.03 INSTALLATION

- A. Concrete Base:
 - 1. Place on prepared subgrade.
 - 2. Properly locate, ensure firm bearing throughout, and plumb first section.
- B. Sections:
 - 1. Carefully inspect precast sections to be joined.
 - 2. Thoroughly clean ends of sections to be joined.
 - 3. Do not use sections with chips or cracks.
- C. Joints:
 - 1. Fill joints between precast sections per manufacturer's recommendation.
 - 2. Joints shall be watertight to prevent entrance of groundwater.
- D. Setting Precast Vault: Install vault to elevations shown on Drawings.
- E. Watertight construction below grade with no open cracks or spalls. Cracking and defective areas of concrete shall be repaired per requirements of Section 03 30 00, Cast-in-Place Concrete.

3.04 PIPE CONNECTION TO VAULT

- A. Install products in accordance with manufacturer's instructions. Grout pipe connections flush with interior and exterior walls.

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. Type of disinfecting solution and method of preparation.
5. Certification that employees working with concentrated chlorine solutions or gas have received appropriate safety training.
6. Method of disposal for highly chlorinated disinfecting water.

1.03 SEQUENCING

- A. Commence disinfection after completion of following:
 - 1. Completion and acceptance of internal painting of system(s).
 - 2. Hydrostatic and pneumatic testing, pressure testing, functional and performance testing and acceptance of pipelines, pumping systems, structures, and equipment.
 - 3. Disinfection of water piping.

PART 2 PRODUCTS

2.01 GENERAL

- A. Components and Materials in Contact with Water for Human Consumption: Comply with the requirements of the Safe Drinking Water Act and other applicable federal, state, and local requirements. Provide certification by manufacturer or an accredited certification organization recognized by the Authority Having Jurisdiction that components and materials comply with the maximum lead content standard in accordance with NSF/ANSI 61 and NSF/ANSI 372.
 - 1. Use or reuse of components and materials without a traceable certification is prohibited.

2.02 WATER FOR DISINFECTION AND TESTING

- A. Clean, uncontaminated, and potable.
- B. Owner will supply potable quality water. Contractor shall convey in disinfected pipelines or containers.

PART 3 EXECUTION

3.01 GENERAL

- A. Conform to AWWA C651 for pipes and pipelines, 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. Pipelines: Disinfect new pipelines that connect to existing pipelines up to point of connection.
 - 2. 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 piping of loose and suspended material.
- E. Allow freshwater and disinfectant solution to flow into pipe or vessel at a measured rate so chlorine-water solution is at specified strength. Do not place concentrated liquid commercial disinfectant in pipeline or other facilities to be disinfected before it is filled with water.

3.02 TURBIDITY

- A. Cleaning of equipment and facilities shall include removal of materials that result in a turbidity exceeding limits stated in Article Testing.

3.03 PIPING

- A. Cleaning: Before disinfecting, clean foreign matter from pipe in accordance with AWWA C651.
- B. Disinfecting Procedure: In accordance with AWWA C651, unless herein modified.

3.04 DISPOSAL OF CHLORINATED WATER

- A. Do not allow flow into a waterway without neutralizing disinfectant residual.
- B. See appendix of AWWA C651 for acceptable neutralization methods.

3.05 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 Owner's laboratory.

C. Chlorine Concentration Sampling and Analysis:

1. Collect and analyze Samples in accordance with AWWA C651.
2. Analysis to be performed by Owner's laboratory. Samples will be analyzed using amperometric titration method for free chlorine as described in latest edition of Standard Methods for Examination of Water and Wastewater.

D. After pipes have been cleaned, disinfected, and refilled with potable water, Owner 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 one sample on each of two consecutive days from each separable section of pipe by standard procedures outlined by state and local regulatory agencies.
4. Sampling points shall be representative and accepted by Engineer.

E. Turbidity Sampling and Analysis:

1. After pipes have been cleaned, disinfected, and refilled with potable water, Owner will take water Samples and have them analyzed for conformance to turbidity limitations for public drinking water supplies. Turbidity shall not exceed 0.3 NTU.
2. If turbidity is in excess of the limit, dispose of the water in accordance with this Specification and applicable regulations, take action to remove source of turbidity, refill system, and retest.

F. 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 to 120-degree pipe saddle for pipe 6 inches and larger with baseplates drilled for anchors bolts.

1. In accordance with Standard Detail 4005-515.
2. Sizes 20 inches through 60 inches, Piping Technology & Products, Inc.; Fig. 2000.

B. Saddle Supports, Pedestal Type:

1. Minimum standard weight pipe stanchion, saddle, and anchoring flange.
2. Nonadjustable Saddle: MSS SP, Type 37 with U-bolt.
 - a. Anvil; Figure 259, sizes 4 inches through 36 inches with Figure 63C base.
 - b. B-Line; Figure B3095, sizes 1 inch through 36 inches with B3088S base.

3. Adjustable Saddle: MSS SP 58, Type 38 without clamp.
 - a. Anvil; Figure 264, sizes 2-1/2 inches through 36 inches with Figure 62C base.
 - b. B-Line; Figure B3092, sizes 3/4 inch through 36 inches with Figure B3088S base.

2.05 CHANNEL TYPE SUPPORT SYSTEMS

- A. Channel Size: 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 |
| Lime, Sodium Permanganate | Stainless steel, FRP, precoated steel | Stainless steel, FRP, precoated steel |
| <p>Notes:</p> <ol style="list-style-type: none"> 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 (1000 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

A. Plastic Piping Systems:

1. Type: Aluminum foil coated adhesive tape.
2. Manufacturers and Products:
 - a. Raychem; AT-180.
 - b. Thermon; AL-20P.
 - c. Nelson; AT-50.

B. Metallic Piping Systems:

1. Type: Glass or polyester cloth pressure sensitive tape.
2. Manufacturers and Products:
 - a. Raychem; GS54 or GT66.
 - b. Thermon; PF-1.
 - c. Nelson; GT-6 or GT-60.

2.05 PIPE MOUNTED THERMOSTAT

- A. Type: Fixed, nonadjustable, set at 40 degrees F.
- B. Sensor: Fluid-filled with 3-foot capillary.
- C. Enclosure: Glass-filled nylon, NEMA 250, Type 4X weatherproof with gasketed lid.
- D. Switch: SP-ST, UL listed, rated 22 amps, 120 to 240V ac.
- E. Manufacturers and Products:
 1. Raychem; DigiTrace Model AMC-F5.
 2. Thermon; E4X-1.
 3. Raychem; DigiTrace Model E507S-LS for hazardous areas.
 4. Thermon; E7-25325 for hazardous areas.

PART 3 EXECUTION

3.01 INSTALLATION

A. General:

1. Install in accordance with the manufacturer's instructions and recommended practices.
2. Provide insulation as specified in Section 40 42 13, Process Piping Insulation, over all pipe heat tracing.

3. Ground metallic structures or materials used for support of heating cable or on which it is installed in accordance with applicable codes.
4. Wiring between power connection points of heat tracing cable branch lines shall be provided by heat tracing system supplier.
5. Provide end of circuit pilot lights on heat tracing circuits for buried piping.

B. Electrical Heating Tape:

1. Determine required length of electrical heating tape by considering length of circuit, number and type of fittings and fixtures, design heating load, and heating tape output.
2. Where design heating load exceeds heating tape capacity, install by spiraling.
3. Derate heating tape capacity when installed on plastic piping.
4. Install on services as follows:

| Service | Piping Material | Placement | Location |
|----------------|------------------------|--|---|
| SP | PVC | On piping inside meter vaults where piping is exposed. | Lake McIntosh Meter Vault and Raw Water Meter Vault |

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 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. Buried Piping: H20-S16 traffic load with 1.5 impact factor, AASHTO HB-17, as applicable.
 4. Thrust Restraints:
 - a. Design for test pressure shown in Piping Schedule.
 - b. Allowable Soil Pressure: 2,000 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.

1.03 SUBMITTALS

- A. Action Submittals:
1. Shop Fabricated Piping:
 - a. Detailed pipe fabrication or spool drawings showing special fittings and bends, dimensions, coatings, and other pertinent information.
 - b. Layout drawing showing location of each pipe section and each special length; number or otherwise designate laying sequence on each piece.
 2. Pipe Wall Thickness: Identify wall thickness and rational method or standard applied to determine wall thickness for each size of each different service including exposed, submerged, buried, and concrete-encased installations for Contractor-designed piping.
 3. Hydraulic Thrust Restraint for Restrained Joints: Details including materials, sizes, assembly ratings, and pipe attachment methods.
 4. Thrust Blocks: Concrete quantity, bearing area on pipe, and fitting joint locations.
 5. 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.

1.04 QUALITY ASSURANCE

A. 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.

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. 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.

B. Threaded Joints: NPT taper pipe threads in accordance with ASME B1.20.1.

C. 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.

D. Flexible Mechanical Compression Joint Coupling:

1. Stainless steel, ASTM A276, Type 305 bands.
2. Manufacturers:
 - a. Pipeline Products Corp.
 - b. Fernco Joint Sealer Co.

2.04 GASKET LUBRICANT

- ### A. Lubricant shall be supplied by pipe manufacturer and no substitute or “or-equal” will be allowed.

2.05 PIPE CORROSION PROTECTION

A. 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.

B. Insulating Flanges, Couplings, and Unions:

1. Materials:
 - a. In accordance with applicable piping material specified in Pipe Data Sheet. Complete assembly shall have ASME B31.3 working pressure rating equal to or higher than that of joint and pipeline.
 - b. Galvanically compatible with piping.
 - c. Resistant for intended exposure, operating temperatures, and products in pipeline.
2. Union Type, 2 Inches and Smaller:
 - a. Screwed or solder-joint.
 - b. O-ring sealed with molded and bonded insulation to body.
3. Flange Type, 2-1/2 Inches and Larger:
 - a. Flanged, complete with bolt insulators, dielectric gasket, bolts, and nuts.
 - b. Bolt insulating sleeves shall be provided full length between insulating washers.
 - c. Ensure fit-up of components of insulated flange assembly to provide a complete functioning installation.
 - d. AWWA C207 steel flanges may be drilled oversize up to 1/8-inch to accommodate insulating sleeves.
 - e. No less than minimum thread engagement in accordance with specified bolting standards will be permitted to accommodate thicknesses of required washers, flanges, and gasket.
4. Flange Insulating Kits:
 - a. Gaskets: Full-face, Type E with elastomeric sealing element. Sealing element shall be retained in a groove within retainer portion of gasket.
 - b. Insulating Sleeves: Full-length 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:
 - 1) Dresser; STAB-39.
 - 2) Baker Coupling Company, Inc.; Series 216.

2.06 THRUST BLOCKS

- A. Concrete: As specified in Section 03 30 00, Cast-in-Place Concrete.

2.07 THRUST TIES

- A. 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.

2.08 FABRICATION

- A. Mark each pipe length on outside with the following:
 - 1. Size or diameter and class.
 - 2. Manufacturer's identification and pipe serial number.
 - 3. Location number on laying drawing.
 - 4. Date of manufacture.
- B. Code markings according to approved Shop Drawings.
- C. Shop fabricate flanged pipe in shop, not in field, and delivered to Site with flanges in place and properly faced. Threaded flanges shall be individually fitted and machine tightened on matching threaded pipe by manufacturer.

2.09 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 04, Painting (Condensed), 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 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. Raised-Face Flanges: Use flat-face flange when joining with flat-faced ductile or cast iron flange.
 - 6. Verify compatibility of mating flange to adapter flange gasket prior to selecting grooved adapter flanging.
 - 7. 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.
 - 8. Threaded flanged joints shall be shop fabricated and delivered to Site with flanges in-place and properly faced.
 - 9. Manufacturer: Same as pipe.
- 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. 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.
- F. Pipe Connections at Concrete Structures: As specified in Article Piping Flexibility Provisions in Section 40 27 01, Process Piping Specialties.
- G. PVC 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.
- H. 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.

3.04 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. Do not route piping in front of or to interfere with access ways, ladders, stairs, platforms, walkways, openings, doors, or windows.
 - 2. Headroom in front of openings, doors, and windows shall not be less than the top of the opening.
 - 3. Do not install piping containing liquids or liquid vapors in transformer vaults or electrical equipment rooms.
 - 4. 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.

3.05 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 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: Maximum 2 inches.
2. Deflection From Vertical Grade: Maximum 1/4 inch.
3. Joint Deflection: Maximum of 75 percent of manufacturer's recommendation.
4. Pipe Cover: Minimum 3 feet, unless otherwise shown.

3.06 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.

3.07 PIPE CORROSION PROTECTION

A. Ductile Iron Pipe:

1. Buried: Wrap with polyethylene bagging.

B. Piping Accessories:

1. Exposed:

- a. Field paint black and galvanized steel, brass, copper, and bronze piping components as specified in Section 09 90 04, Painting (Condensed), 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 04, Painting (Condensed).
- b. Bolts, Nuts, and Similar Items: Coat with bituminous paint.
- c. Flexible Couplings and Similar Items: Wrap with heat shrink wrap.
- d. Buried Valves and Similar Elements on Wrapped Pipelines: Coat with bituminous paint and wrap entire valve in polyethylene encasement.

C. Polyethylene Encasement: Install in accordance with AWWA C105/A21.5 and manufacturer's instructions.

D. Tape Coating System: As specified in Section 09 90 04, Painting (Condensed).

E. Heat Shrink Wrap: Apply in accordance with manufacturer's instructions to surfaces that are cleaned, prepared, and primed.

F. Insulating Flanges, Couplings, and Unions:

1. Applications:

- a. Dissimilar metal piping connections.
- b. Connections to existing metallic pipe.
- c. Where required for electrically insulated connection.

2. Pipe Installation: Align and install insulating joints according to manufacturer's recommendations. Bolt lubricants that contain graphite or other metallic or electrically conductive components that can interfere with the insulating capabilities of the completed flange shall not be used.

3.08 THRUST RESTRAINT

A. Location:

1. Buried Piping: 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. Ductile Iron Pipe: Attach with socket clamps anchored against grooved joint coupling or flange.
2. 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.

3.09 SLAB, FLOOR, WALL, AND ROOF PENETRATIONS

- #### A. Application and Installation: As specified in Section 40 27 01, Process Piping Specialties.

3.10 BRANCH CONNECTIONS

- #### A. Do not install branch connections smaller than 1/2-inch nominal pipe size, including instrument connections, unless shown otherwise.
- #### B. When line of lower pressure connects to a line of higher pressure, requirements of Piping Data Sheet for higher pressure rating prevails up to and including first block valve in the line carrying the lower pressure, unless otherwise shown.

C. Threaded Pipe Tap Connections:

1. Ductile Iron Piping: Connect only with service saddle or at tapping boss of a fitting, valve body, or equipment casting.
2. Welded Steel or Alloy Piping: Connect only with welded threadolet or half-coupling as specified on Piping Data Sheet.
3. Limitations: Threaded taps in pipe barrel are unacceptable.

3.11 INSULATION

- A. See Section 40 42 13, Process Piping Insulation.

3.12 HEAT TRACING

- A. See Section 40 05 33, Pipe Heat Tracing.

3.13 DISINFECTION

- A. See Section 33 13 00, Disinfecting of Water Utility Distribution.

3.14 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 04, Painting.

3.15 FIELD QUALITY CONTROL

- A. Pressure Leakage Testing: As specified in Section 40 80 01, Process Piping Leakage Testing.

3.16 CLEANING

- A. Following assembly and testing, and prior to disinfection and final acceptance, flush pipelines, except as stated below, with water at 2.5 fps minimum flushing velocity until foreign matter is removed.
- B. Insert cone strainers in flushing connections to attached equipment and leave in-place until cleaning is complete.
- C. Remove accumulated debris through drains 2 inches and larger or by removing spools and valves from piping.

3.17 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 |
| 40 27 00.10 | Polyvinyl Chloride (PVC) Pipe and Fittings |
| 40 27 00.13 | Copper and Copper Alloy Pipe, Tubing, and Fittings |

END OF SECTION

PIPING SCHEDULE LEGEND**EXPOSURE**

| | |
|-----|------------------|
| ALL | All |
| BUR | Buried |
| EXP | Exposed |
| SUB | Submerged |
| ENC | Concrete Encased |

MATERIAL

| | |
|------|---------------------------|
| CLDI | Cement-Lined Ductile Iron |
| COP | Copper |
| PVC | Polyvinyl Chloride |
| STL | Steel |

JOINT TYPE

| | |
|-----|---------------------------------------|
| FL | Flanged |
| 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 |
| PC | Test per Uniform Plumbing Code |
| NA | Not Applicable |

| Piping Schedule | | | | | | | | | | |
|---------------------------------------|--------|-------------------------------|---------------------|--------------------|--------------------------|---------------|----------------------|--|-------------------------------|---|
| Service | Legend | Size(s) (In.) ¹ | Exposure | Piping Material | Specification Section | Joint Type | Coating ² | Test Pressure and Type (psig-x), x = Type indicated in Legend | Pipe Color and Label | Remarks |
| Chemical Carrier Pipe | CP | ALL | BUR, EXP, ENC | PVC | 40 27 00.10 | W | None | NA | Light Green, “Liquid Lime” | |
| Chemical Carrier Pipe, Steel | CPS | ALL | BUR | STL | 40 27 00.10 | W | None | NA | None | Steel carrier pipe is to be used where depth of cover > or = to 3 feet is not possible due to existing yard piping conflicts. See Drawings for specific piping runs where steel carrier pipe is required. |
| Drain (Process) | DR | ALL | BUR, EXP, ENC | PVC | 40 27 00.10 | W | None | G | None | |
| Dosed Water Sample | DWS | ALL | BUR, EXP | PVC | 40 27 00.10 | W | None | 50, H | None, “Dosed Water Sample” | |
| Hot Water | HW | <=3” | EXP | COP | 40 27 00.13 | FL, S, W | None | 150/H | None, “Hot Water” | All piping and connections provided by |

| Piping Schedule | | | | | | | | | | |
|----------------------------|--------|-------------------------------|-------------|--------------------|--------------------------|---------------|----------------------|--|--------------------------------|--|
| Service | Legend | Size(s) (In.) ¹ | Exposure | Piping Material | Specification Section | Joint Type | Coating ² | Test Pressure and Type (psig-x), x = Type indicated in Legend | Pipe Color and Label | Remarks |
| Lime Slurry | LI | ALL | BUR, EXP | PVC Tube | 40 27 00.10 | | | 40, H | Light Green, “Liquid Lime” | Provided by Lime System Supplier |
| Overflow | OF | <=3” | EXP | PVC | 40 27 00.10 | W | None | NA | None | |
| Raw Water Sample | RWS | ALL | EXP | PVC | 40 27 00.10 | W | None | 50, H | None, “Raw Water Sample” | |
| Sodium Permanga nate | SP | ALL | EXP | PVC | 40 27 00.10 | W | None | 50, H | None, “Sodium Permanganate” | |
| Tempered Water | TW | <=3” | EXP | COP | 40 27 00.13 | FL, S, W | None | 150/H | None, “Tempered Water” | |
| Water, Potable | W1 | <=3” | BUR, ENC | PVC | 40 27 00.10 | W | None | 150/H | None | |
| Water, Potable | W1 | >=4” | BUR | CLDI | 40 27 00.01 | PRJ | | 150/H | Note 3 | |
| Water, Potable | W1 | <=3” | EXP | COP | 40 27 00.13 | FL, S, W | None | 150/H | None, “W1” | |

| Piping Schedule | | | | | | | | | | |
|---|--------|-------------------------------|----------|--------------------|--------------------------|---------------|----------------------|--|-------------------------|---------|
| Service | Legend | Size(s) (In.) ¹ | Exposure | Piping Material | Specification Section | Joint Type | Coating ² | Test Pressure and Type (psig-x), x = Type indicated in Legend | Pipe Color and Label | Remarks |
| Backflow prevented potable water | W2 | <= 3" | EXP | COP | 40 27 00.13 | FL, S, W | None | 150/H | None, "W2" | |
| 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 04, Painting (Condensed), and as specified in Article Pipe Corrosion Protection. ³ Manufacturer's standard asphaltic coating per AWWA C151 | | | | | | | | | | |

| SECTION 40 27 00.01 CEMENT-MORTAR-LINED DUCTILE IRON PIPE AND FITTINGS | |
|---|--|
| Item | Description |
| General | <p>Materials in contact with potable water shall conform to NSF 61 acceptance.</p> <p>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).</p> |
| Pipe | <p>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.</p> <p>Exposed Pipe Using Grooved End and Flange Joints: AWWA C115/A21.15, thickness Class 53 minimum, 250 psi minimum working pressure.</p> |
| Lining | Cement-mortar: AWWA C104/A21.4. |
| Fittings | <p>Lined and coated same as pipe.</p> <p>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.</p> <p>Flange: AWWA C110/A21.10 ductile iron, faced and drilled, Class 125 flat face. Gray cast iron will not be allowed.</p> |

| SECTION 40 27 00.01 CEMENT-MORTAR-LINED DUCTILE IRON PIPE AND FITTINGS | |
|---|--|
| Item | Description |
| Joints | <p>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.</p> <p>Grooved End: Rigid type radius cut conforming to AWWA C606, 250 psi minimum working pressure; Victaulic.</p> <p>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.</p> <p>Branch connections 3 inches and smaller, shall be made with service saddles as specified in Section 40 27 01, Process Piping Specialties.</p> |
| Couplings | <p>Grooved End: 250 psi minimum working pressure, malleable iron per ASTM A47/A47M or ductile iron per ASTM A536; Victaulic.</p> <p>Grooved End Adapter Flanges: 250 psi minimum working pressure, malleable iron per ASTM A47/A47M or ductile iron per ASTM A536; Victaulic.</p> |
| Bolting | <p>Mechanical, Proprietary Restrained, and Grooved End Joints: Manufacturer's standard.</p> <p>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.</p> |
| Gaskets | <p>General: Gaskets in contact with potable water shall be NSF 61 certified.</p> <p>Proprietary Restrained Joints; Water and Sewage Service: Rubber conforming to AWWA C111/A21.11.</p> <p>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.</p> <p>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.</p> <p>Gasket pressure rating to equal or exceed the system hydrostatic test pressure.</p> |

| SECTION 40 27 00.01 CEMENT-MORTAR-LINED DUCTILE IRON PIPE AND FITTINGS | |
|---|--------------------------|
| Item | Description |
| 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 | 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: |
| | Screwed: | |
| | 2" & smaller | Schedule 40. |
| | Welded: | |
| | 2-1/2" thru 10" | Schedule 40. |
| | 12" thru 16" | Schedule 30. |
| | 18" thru 24" | Schedule 20. |
| | Grooved: | |
| | 2-1/2" thru 6" | Schedule 40. |
| | 8" thru 12" inch | Schedule 30. |
| | 14" | Standard weight. |
| Joints | 2" & smaller | Threaded or flanged at valves and equipment or grooved end meeting the requirements of AWWA C606. |
| | 2-1/2" & larger | Butt-welded 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. |
| | 2-1/2" & larger | Butt Welded: Wrought carbon steel butt-welding, ASTM A234/A234M, Grade WPB meeting the requirements of ASME B16.9; fitting wall thickness to match adjoining pipe; long radius elbows unless shown otherwise. |

| SECTION 40 27 00.03 CARBON STEEL PIPE AND FITTINGS—GENERAL SERVICE | | |
|---|-----------------|---|
| Item | Size | Description |
| | | Grooved End: Malleable iron ASTM A47/A47M, ductile iron ASTM A536, forged steel ASTM A234/A234M, or factory fabricated from ASTM A53/A53M pipe. Grooved ends to accept couplings without field preparation. Victaulic Co.; Anvil International, Inc., Gruvlok; Shurjoint Piping Products. |
| 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. |
| | 2-1/2" & larger | Butt-welding or grooved end tee in conformance with Fittings specified above. |
| 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. |
| | 2-1/2" & larger | Butt-Welded Systems: Forged carbon steel, ASTM A105/A105M, ASME B16.5 Class 150 or Class 300 slip-on or welding neck, 1/16-inch raised face; weld neck bore to match pipe internal diameter. Use weld neck flanges when abutting butt-weld fittings. Weld slip-on flanges inside and outside. Grooved End Adapter Flange: Malleable iron ASTM A47/A47M or ductile iron ASTM A536. Victaulic Style 741 or 743; Anvil International, Inc., Gruvlok Figure 7012 or 7013; Shurjoint Model 7041-A. Include stainless steel washer plates as required for mating to serrated faces and lined valves and equipment. Cast Iron Mating Flange: AWWA C207, Class D or E, hub or ring type to mate with ASME B16.1, Class 125 cast-iron flange. AWWA C207 Class F hub type or ASTM A105/A105M, ASME B16.5 Class 300 to mate with ASME B16.1 Class 250 cast-iron flange. |

| SECTION 40 27 00.03 CARBON STEEL PIPE AND FITTINGS—GENERAL SERVICE | | |
|---|-----------------|---|
| Item | Size | Description |
| 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. |
| Couplings | 2-1/2" & larger | Grooved End: Rigid joint malleable iron, ASTM A47/A47M or ductile iron, ASTM A536. Victaulic Co.; Anvil International, Inc., Gruvlok; Shurjoint Piping Products. Screwed End: Malleable iron, ASTM A197/A197M or ASTM A47/A47M. |
| 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. |

| SECTION 40 27 00.03 CARBON STEEL PIPE AND FITTINGS—GENERAL SERVICE | | |
|---|--------------|---|
| Item | Size | Description |
| | | 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 00.10 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 | <p>Flat Face Mating Flange: Full faced 1/8-inch-thick ethylene propylene (EPR) rubber.</p> <p>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.</p> |
| 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 00.13 COPPER AND COPPER ALLOY PIPE, TUBING, AND FITTINGS | |
|---|--|
| Item | Description |
| General | Materials in contact with potable water shall conform to NSF 61 acceptance. |
| Tubing | Seamless, conforming to ASTM B88 as follows: Oxygen service.....Type K, hard drawn Water (buried)Type K, soft or hard temper Water (exposed).....Type L, hard drawn Domestic hot waterType L, hard drawn Compressed air serviceType L, hard drawn Laboratory air serviceType L, hard drawn Laboratory vacuum serviceType L, hard drawn Refrigerant serviceType L, hard drawn P-Trap priming serviceType L, soft temper Sample line serviceType L, hard drawn Laboratory gas serviceType L, hard drawn |
| Fittings | ASTM B75 commercially pure wrought copper, socket joint, dimensions conforming to ASME B16.22. |
| Flanges | Class 150, ASTM B75 commercially pure wrought copper, socket joint, ASME B16.24 standard. |
| Bolting | ASTM A307, carbon steel, 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. |
| Gaskets | 1/16-inch-thick non-asbestos compression type, full face, Cranite, John Manville. |
| Solder | Joints 2-1/2 Inch and Smaller: Wire solder (95 percent tin), conforming to ASTM B32 Alloy Grade Sn95. Do not use cored solder. Joints Larger Than 2-1/2 Inch: Wire solder, melt range approximately 440 degrees F to 660 degrees F, conforming to ASTM B32 Alloy Grade HB or HN. Do not use cored solder. |

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.

PART 2 PRODUCTS

2.01 GENERAL

- A. Provide required piping specialty items, whether shown or not shown on Drawings, as required by applicable codes and standard industry practice.
- B. Rubber ring joints, mechanical joints, flexible couplings, and proprietary restrained ductile iron pipe joints are considered flexible joints; welded, screwed, and flanged pipe joints are not considered flexible.
- C. Components and Materials in Contact with Water for Human Consumption: Comply with the requirements of the Safe Drinking Water Act and other applicable federal, state, and local requirements. Provide certification by manufacturer or an accredited certification organization recognized by the Authority Having Jurisdiction that components and materials comply with the maximum lead content standard in accordance with NSF/ANSI 61 and NSF/ANSI 372.
 - 1. Use or reuse of components and materials without a traceable certification is prohibited.

2.02 CONNECTORS

- A. Teflon Bellows Connector:
 - 1. Type: Two convolutions, unless otherwise shown, with metal reinforcing bands.
 - 2. Flanges: Ductile iron, drilled 150 psi ASME B16.5 standard.
 - 3. Working Pressure Rating: 140 psi, minimum, at 120 degrees F.
 - 4. Thrust Restraint: Limit bolts to restrain force developed by specified test pressure.

5. Manufacturers and Products:
 - a. Garlock; Style 214.
 - b. Resistoflex, No. R6904.
 - c. Unisource Manufacturing, Inc.; Style 112.
 - d. Proco Products, Inc.; Series 442.

B. 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.

C. 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. Flexible Sleeve Type Coupling:

1. Manufacturers and Products:
 - a. Steel Pipe:
 - 1) Dresser Piping Specialties; Style 38.
 - 2) Smith-Blair, Inc.; Style 411.
 - b. Ductile Iron Pipe:
 - 1) Dresser Piping Specialties; Style 253.
 - 2) Smith-Blair, Inc.; Style 441.

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.

2.05 PIPE SLEEVES

A. Steel Pipe Sleeve:

1. Minimum thickness 3/16-inch Type 316L stainless steel.
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.

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.
- 4. Manufacturer: Thunderline Corp., Link-Seal Division.

2.06 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.

2.07 MISCELLANEOUS SPECIALTIES

A. Basket Strainer:

1. Service Conditions:
 - a. Material Handled: Sodium Permanganate (20 percent).
 - b. Temperature of Material Handled: 50 degrees F, minimum to 100 degrees F, maximum.
 - c. Specific Gravity of Material Handled: 1.16.
 - d. pH Range of Material Handled: 5-8.
 - e. All materials used shall be compatible with materials handled and the environment present.
2. Strainer Capacity: 0.20 gpm, maximum pressure drop shall not exceed 2 psi at 0.2 gpm.
3. Screen: Capable of removing material larger than 0.0625 inch in diameter.
4. Strainer: Double chamber design of PVC construction.
5. Permit one basket strainer to be removed for cleaning while other basket is in operation.
6. Inlet and Outlet Connection: 2 inch, flanged with EPDM seals.
7. Baskets: PVC
8. Wearing parts shall be replaceable without removing strainer from line.
9. Manufacturer: Hayward or approved equal.

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.
 - f. Alarms: Magnetically operated proximity switches.

PART 3 EXECUTION

3.01 GENERAL

- A. Provide accessibility to piping specialties for control and maintenance.

3.02 PIPING FLEXIBILITY PROVISIONS

A. General:

1. Thrust restraint shall be provided as specified in Section 40 27 00, Process Piping—General.
2. Install flexible couplings to facilitate piping installation, in accordance with approved shop drawings.

B. Flexible Joints at Concrete Structures: Install 18 inches or less from face of structures; joint may be flush with face.

3.03 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.
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.

3.04 SERVICE SADDLES

A. Ferrous Metal Piping (except stainless steel): Double-strap iron.

B. Plastic Piping: Nylon-coated iron.

3.05 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 and transition couplings.

3.06 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. All Other Piping: Elastomer bellows connector.
- C. Limit Bolts and Control Rods: Tighten snug prior to applying pressure to system.

3.07 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.

3.08 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.

3.09 CHEMICAL INJECTOR SYSTEM

- A. Install in accordance with manufacturer's instructions.

3.10 MISCELLANEOUS SPECIALTIES

- A. Safety Equipment:

1. System Shutoff Valves:
 - a. Shutoff valves shall give visual indication of position (open or closed).
 - b. Shutoff valves shall be locable 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, when valve is full open, shall be a minimum 20 inches in diameter at 60 inches above standing surface.
 - e. Water arcs from eyewash spray heads must cross. Test with eyewash gauge; Haws-Drinking Faucet Co., Model 9015.
 - f. Minimum flow rates for safety showers shall be 20 gpm.
 - g. Minimum flow rates for eyewashes shall be 3 gpm.
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 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.

1.02 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
 - a. Product data sheets for each make and model. Indicate valve Type Number, applicable Tag Number, and facility name/number or service where used.
 - b. Complete catalog information, descriptive literature, specifications, and identification of materials of construction.
 - c. Certification for compliance to NSF/ANSI 61 for valves used for drinking water service.
 - d. 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. Dimensional drawings of backup power supply control panel.
 - g. Power and control wiring diagrams of backup power supply panel, including terminals and numbers.
 - h. Sizing calculations for open-close/throttle and modulating valves.

B. Informational Submittals:

1. Manufacturer's Certificate of Compliance, in accordance with Section 01 43 33 Manufacturer's Field Services, for:
 - a. Electric actuators; full compliance with AWWA C542.
2. Manufacturer's Certificate of Proper Installation, in accordance with Section 01 43 33, Manufacturers' Field Services.

PART 2 PRODUCTS

2.01 GENERAL

- A. Valves to include operator, actuator, handwheel, chain wheel, extension stem, floor stand, operating nut, chain, wrench, and accessories to allow a complete operation from the intended operating level.

- B. Valve to be suitable for intended service. Renewable parts not to be of a lower quality than specified.
- C. Valve same size as adjoining pipe, unless otherwise called out on Drawings or in Supplements.
- D. Valve ends to suit adjacent piping.
- E. Resilient seated valves shall have no leakage (drip-tight) in either direction at valve rated design pressure. All other valves shall have no leakage (drip-tight) in either direction at valve rated design pressure, unless otherwise allowed for in this section or in stated valve standard.
- F. Size operators and actuators to operate valve for full range of pressures and velocities.
- G. Valve to open by turning counterclockwise, unless otherwise specified.
- H. Factory mount operator, actuator, and accessories.
- I. Components and Materials in Contact with Water for Human Consumption: Comply with the requirements of the Safe Drinking Water Act and other applicable federal, state, and local requirements. Provide certification by manufacturer or an accredited certification organization recognized by the Authority Having Jurisdiction that components and materials comply with the maximum lead content standard in accordance with NSF/ANSI 61 and NSF/ANSI 372.
 - 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 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 04, Painting (Condensed).
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. If valve and/or operator will not be field-coated, 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) Stockham; Figure B-140.
2. Type V132 Resilient Seated Gate Valve 2 Inches to 12 Inches, for Buried Service:
 - a. Iron body, resilient seat, bronze stem and stem nut, push-on, NPT threaded, or mechanical joint ends, nonrising stem, in accordance with AWWA C509, 2-inch operating nut, minimum design working water pressure 200 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, Model KS-FW.
 - 2) Clow Valve Company; AWWA C509, Model 2639/2640.

B. Globe Valves:

1. Type V235 Angle Type Hose Valve 3/4 Inch:
 - a. 3/4-inch NPT female inlet, 3/4-inch male hose thread outlet, heavy rough brass body rated 125 psi, lockshield bonnet, removable handle, atmospheric vacuum breaker conforming to ASSE 1011 and IAPMO code.
 - b. Manufacturers and Products:
 - 1) Acorn; 8126, surface pipe mount valve, bent nose without flange.
 - 2) Acorn; 8121, surface mount through wall valve, bent nose with flange.
 - 3) Acorn; 8131, pipe and pedestal mounted valve located above 6 inches, straightnose.
 - 4) Acorn; 8136, pedestal mounted valve located lower than 6 inches, inverted nose.

C. Ball Valves:

1. 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. For steam service, provide stainless steel ball and stem.

- 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.
 - 2. Type V307 Stainless Steel Ball Valve 2 Inches and Smaller:
 - a. Three-piece, full port, ASTM A276 GR 316 or ASTM A351/A351M GR CF8M stainless steel body and end pieces, Type 316 stainless steel ball, NPT threaded ends, reinforced PTFE seats, seals, and packing, adjustable packing gland, blowout-proof stainless steel stem, stainless steel lever operator with vinyl grip, rated 800 psig to 1,000 psig CWP, complies with MSS SP-110.
 - b. Manufacturers and Products:
 - 1) Conbraco Apollo; 86R-100/86-500 Series.
 - 2) Nibco; T-595-S6-R-66-LL.
 - 3. Type V330 PVC Ball Valve 2 Inches and Smaller:
 - a. Rated 150 psi at 73 degrees F, with ASTM D1784, Type I, Grade 1 polyvinyl chloride body, ball, and stem, end entry, double union design, solvent-weld socket ends, elastomer seat, Viton or Teflon O-ring stem seals, to block flow in both directions.
 - b. Manufacturers and Products:
 - 1) Nibco; Chemtrol Tru-Bloc.
 - 2) ASAHI/America; Type 21.
 - 3) Spears; True Union.
 - 4. Type V331 PVC Ball Valve 3 Inches and 4 Inches:
 - a. Rated 150 psi at 73 degrees F, with ASTM D1784 Type I, Grade 1 PVC full port body, Teflon seat, Viton O-ring stem, face and carrier seals, end entry design with dual union, solvent-weld socket ends, or single union ball valve with flanged ends drilled to ASME B16.1. 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.

D. Plug Valves:

- 1. Type V464 Corporation Stop 1/2 Inch to 2 Inches:
 - a. AWWA C800 type, tapered threaded inlet, except when connecting to tapped fittings which require IPS tapered threads,

outlet compression connection or IPS threads to suit connecting pipe, stops 1 inch and smaller rated 100 psi, larger stops rated 80 psi.

- b. Manufacturers and Products:
 - 1) Ford Meter Box Co.; F700.
 - 2) Mueller Co.; B-25025N.

E. Check and Flap Valves:

- 1. Type V640 Double Check Valve Backflow Prevention Assembly
3/4 Inch to 10 Inches:
 - a. Two resilient seated check valves, two nonrising stem resilient-seated isolation valves, test cocks, in accordance with AWWA C510, 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 850.
 - 2) Danfoss Flomatic; Model DCVE/DCV.
 - 3) Watts; Series 007/709.
- 2. Type V642 Reduced-Pressure Principle Backflow Prevention Assembly
3/4 Inch to 10 Inches:
 - a. Two resilient seated check valves with an independent relief valve between the valves, two nonrising stem outside screw and yoke resilient-seated isolation valves, test cocks, in accordance with AWWA C511, rated 175 psi maximum working pressure, meets requirements of USC Foundation For Cross-Connection Control and Hydraulic Research.
 - b. Manufacturers and Products:
 - 1) FEBCO; Model 860.
 - 2) Danfoss Flomatic; Model RPZE/RPZ.
 - 3) Watts; Series 009/909.

F. Self-Regulated Automatic Valves:

- 1. Type V710 Pressure-Reducing Valve 2-1/2 Inches and Smaller:
 - a. Direct diaphragm operated, spring controlled, bronze body, NPT threaded ends, 200-psig rated, minimum, for service in plant water supply to the lime system. Outlet pressure shall be regulated to 65 psi.
 - b. Manufacturer and Products:
 - 1) Fisher, Type 75A.
 - 2) Watts, Series 223.

2. Type V720 PVC Pressure Relief, By-Pass Relief, Back-Pressure Regulator, Back-Pressure, Anti-Siphon Valve 1/2 Inch to 2 Inches:
 - a. Direct acting diaphragm, spring controlled, in-line pattern, NPT threaded inlet and outlet, 150 psi design pressure.
 - b. PVC body, Teflon or Viton diaphragm, PVC or Teflon piston, high-density polyethylene or stainless steel adjusting bolt and locknut, stainless steel or coated steel spring, stainless steel fasteners.
 - c. Designed to open when upstream pressure reaches setpoint; set pressure adjustable from 10 psi to 100 psi, minimum. Factory set pressure setting at 25 psi for back-pressure and anti-siphon valves, 10 psi for pressure relief valves, 100 psi for bypass relief valves, and 50 psi for back-pressure regulator valves.
 - d. Manufacturers and Products:
 - 1) Plast-O-Matic; Series RVDT.
 - 2) Griffco; Series BPV.
 - 3) Primary Fluid Systems; TOP Valve.

G. Miscellaneous Valves:

1. Type V903 Diaphragm Valve, 1/2 Inch to 4 Inches:
 - a. Weir type with PVC Type 1, Grade 1 body, PTFE with EPDM backing diaphragm, [flanged ends, handwheel operator, position indicator, adjustable travel stop, clear molded acrylic stem cap.
 - b. Manufacturers and Products:
 - 1) ASAHI/AMERICA; Diaphragm Valve Type 14.
 - 2) ITT Engineered Valves; Dia-Flo.
 - 3) Saunders Valve; Diaphragm Valve.

2.06 OPERATORS AND ACTUATORS

A. Manual Operators:

1. General:
 - a. For AWWA valves, operator force not to exceed requirements of applicable valve standard. Provide gear reduction operator when force exceeds requirements.
 - b. For non-AWWA valves, operator force not to exceed applicable industry standard or 80 pounds, whichever is less, under operating condition, including initial breakaway. Provide gear reduction operator when force exceeds requirements.
 - c. Operator self-locking type or equipped with self-locking device.
 - d. Position indicator on quarter-turn valves.

- e. Worm and gear operators one-piece design, worm-gears of gear bronze material. Worm of hardened alloy steel with thread ground and polished. Traveling nut type operator's threaded steel reach rod with internally threaded bronze or ductile iron nut.
- 2. Exposed Operator:
 - a. Galvanized and painted handwheel.
 - b. Cranks on gear type operator.
 - c. Chain wheel operator with tieback, extension stem, floor stand, and other accessories to permit operation from normal operation level.
 - d. Valve handles to take a padlock, and wheels a chain and padlock.
- 3. Buried Operator:
 - a. Buried service operators on valves larger than 2-1/2 inches shall have a 2-inch AWWA operating nut. Buried operators on valves 2 inches and smaller shall have cross handle for operation by forked key. Enclose moving parts of valve and operator in housing to prevent contact with the soil.
 - b. Buried service operators to be grease packed and gasketed to withstand submersion in water to 20 feet minimum.
 - c. Buried valves shall have extension stems, bonnets, and valve boxes.

B. Electric Motor Actuators, 480 Volts:

- 1. Project includes replacing hydraulic actuators with electric actuator for three existing Pratt valves. Two valves actuators are required to be fail closed and provided with backup power supply control panels.
- 2. 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.
- 3. 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.
4. Open-Close (O/C) Service:
 - a. Size motors for one complete OPEN-CLOSE-OPEN cycle no less than once every 10 minutes.
 - b. LOCAL-OFF-REMOTE Selector Switch, padlockable in each position:
 - 1) Integral OPEN-STOP-CLOSE momentary pushbuttons with seal-in circuits to control valve in LOCAL position.
 - 2) Remote OPEN-STOP-CLOSE momentary control dry contact inputs in REMOTE position. Integral seal-in circuits for remote OPEN and CLOSE commands; valve travel stops when remote STOP contact opens.
 - 3) Auxiliary contact that closes in REMOTE position.
 - c. OPEN and CLOSED indicating lights.
 - d. Integral reversing motor starter with built-in overload protection.
 5. 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.
 6. Control Features: Electric motor actuators with features as noted above, and as modified/supplemented in Electric Actuated Valve Schedule.
 7. Manufacturers and Products:
 - a. Flowserve Limitorque; MX actuators.
 - b. Rotork.

2.07 ACCESSORIES

A. Pratt Series BUPS Backup Power Supply Control Panel (LPC-1 and LCP-2):

1. Provide Pratt series backup power supplied, housed in NEMA 4X enclosure. The Pratt series BUPS shall be properly sized such that it will satisfy and complete all fail safe conditions at full power.
2. The control panel shall have 480V, three phase input and output power. Provide any power transformer internal to control panel to power controls or battery system.
3. Provide advanced Battery Management System (ABM). The BUPS shall be electrically isolatable, equipped with input and output circuit breakers, and properly sized according to the application. Batteries in the BUPS shall be of the sealed, maintenance free type. Vented lead-acid (Antimony) flooded electrolyte batteries are not acceptable. Recharge time for the system shall not exceed 6 hours.

4. The series BUPS shall effectively operate within the temperature range of 32-104 degrees F (0-40 degrees C). On-line efficiency shall be greater than 96 percent. Output frequency distortion shall be less than plus or minus 0.5 percent. Using a Buck/Boost output voltage system, output voltage shall not exceed plus or minus 5 percent of nominal voltage.
 5. The backup control panel interfaces with existing pump motor starter and plant telemetry panel. The series BUPS (LCP-1 and LCP-2) shall provide for the following operator interfaces:
 - a. LOCAL/REMOTE selector switch.
 - b. OPEN/CLOSE pushbutton.
 - c. Emergency STOP selector switch.
 - d. Reset pushbutton.
 6. The control panel shall provide for the following inputs/outputs:
 - a. Valve OPEN command from motor starter.
 - b. Valve CLOSE Command from motor starter.
 - c. Valve OPEN status to motor starter.
 - d. Valve CLOSE Status to motor starter.
 - e. Valve/pump failure to motor starter (normal closed open to stop pump).
 - f. High pump discharge pressure from Pump Discharge pressure switch.
 - g. Limit switch from existing pump check valve (closes when valve fully closed).
 - h. Limit switch from existing check valve (closes when not fully open).
 7. Functional requirements: The Series BUPS (FCP-1 and FCP-2) shall interface with existing pump starter logic. Provide the following logic in BUPS panel:
 - a. When Valve Open Command is received and high discharge pressure setpoint is reached, open discharge valve.
 - b. If pressure switch set point not reached after adjustable time delay initiate VALVE/PUMP FAILURE alarm, stop pump and close valve.
 - c. If emergency stop push button is pushed, send VALVE/PUMP FAILURE alarm.
 - d. A valve/pump failure alarm shall require manual reset at control panel.
- B. 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 Drawings and/or in Valve Schedule.

C. Limit Switch:

1. Factory installed NEMA 4X limit switch by actuator manufacturer.
2. SPST, rated at 5 amps, 120 volts ac.

D. T-Handled Operating Wrench:

1. One galvanized operating wrench, 4 feet long.
2. Manufacturers and Products:
 - a. Mueller; No. A-24610.
 - b. Clow No.; F-2520.

E. 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.
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. Screwed Ends:

1. Clean threads by wire brushing or swabbing.
2. Apply joint compound.

B. PVC and CPVC Valves: Install using solvents approved for valve service conditions.

C. 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, and Ball Valves:
 - a. Install operating stem vertical when valve is installed in horizontal runs of pipe having centerline elevations 4 feet 6 inches or less above finished floor, unless otherwise shown.
 - b. Install operating stem horizontal in horizontal runs of pipe having centerline elevations greater than 4 feet 6 inches above finish floor, unless otherwise shown.
- 3. Check Valves:
 - a. Install valve in accordance with manufacturer's instructions and provide required distance from immediate upstream fitting.
 - b. Install valve in vertical flow (up) piping only for gas services.
 - c. Install swing check valve with shaft in horizontal position.
 - d. Install double disc swing check valve to be perpendicular to flow pattern when discs are open.
- D. Locate valve to provide accessibility for control and maintenance. Install access doors in finished walls and plaster ceilings for valve access.
- E. 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.

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. Count and record number of turns to open and close valve; account for discrepancies with manufacturer's data.
- D. Set, verify, and record set pressures for relief and regulating valves.
- E. Automatic valves to be tested in conjunction with control system testing. Set opening and closing speeds, limit switches, as required or recommended by Engineer.
- F. Test hydrostatic relief valve seating; record leakage. Adjust and retest to maximum leakage of 0.1 gpm per foot of seat periphery.

3.03 MANUFACTURER'S SERVICES

- A. Valve(s) as listed below require manufacturer's field services: Electric actuated valves at Lake Horton Raw Water Pump Station.
- B. Manufacturer's Representative: Present at Site for minimum person-days listed below, travel time excluded:
 - 1. 1 person-day for installation assistance and inspection.
 - 2. 1 person-day for functional testing and completion of Manufacturer's Certificate of Proper Installation.
- C. See Section 01 43 33, Manufacturers' Field Services, and Section 01 91 14, Equipment Testing and Facility Startup.

3.04 SUPPLEMENTS

- A. The supplement listed below, following "End of Section," is part of this Specification.
 - 1. Electric Actuated Valve Schedule.
 - 2. Self-Regulated 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 |
| FV-1 | Pratt Ball Valve w/ Double E-LOK® Seat | 480-volt, three-phase | 14 | Raw Water | 5,500 | 300 | T | | B, M |
| FV-2 | Pratt Ball Valve w/ Double E-LOK® Seat | 480-volt, three-phase | 14 | Raw Water | 5,500 | 300 | T | | B, M |
| FV-3 | Pratt Rubber Seated Butterfly Valve w/ E-LOK® Seat | 480-volt, three-phase | 24 | Raw Water | 7,000 | 300 | O/C | | C |
| <p>Service: O/C = Open-Close, T = Throttling, M = Modulating</p> <p>Control Feature Modifications/Supplements:</p> <p>A = Actuator shall open valve upon loss of signal.</p> <p>B = Actuator shall close valve upon loss of signal.</p> <p>C = Actuator shall remain in last position upon loss of signal.</p> <p>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.</p> <p>E = Remote OPEN-CLOSE maintained dry contacts; travel stops when remote contact opens, or when end of travel limit is reached.</p> <p>F = Three 24-volt dc interposing relays for remote OPEN-STOP-CLOSE control. Relays powered externally, thereby permitting valve control from greater distances.</p> <p>G = Motor and control enclosure(s) NEMA 250, Type 4 with 120-volt space heaters.</p> <p>H = Motor and control enclosure(s) NEMA 250, Type 6 (IP 68) with 120-volt space heaters.</p> <p>I = Motor and control enclosure(s) NEMA 250, Type 7 with 120-volt space heaters.</p> <p>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.</p> <p>K = 120-volt secondary control power transformer.</p> <p>L = Externally operable power disconnect switch.</p> <p>M = Provide valve actuator with backup power supply panel.</p> | | | | | | | | | |

| Self-Regulated Valve Schedule | | | | | | | |
|--|----------------|---------------|-----------------|------------------|--------------|------------|----------------|
| Tag No. | Valve Type No. | Size (inches) | Inlet* Pressure | Outlet* Pressure | Maximum psig | Flow (gpm) | Fluid (Note 1) |
| PRV-651 | V710 | | | | | | |
| PSV-X-X | V720 | ½ “ | Note 2 | Note 2 | Note 2 | Note 2 | SP |
| PSV-X-X | V720 | ½ “ | Note 2 | Note 2 | Note 2 | Note 2 | SP |
| *Inlet Pressure = Set pressure for pressure relief valve or downstream set pressure for pressure reducing valve. 1) See pipe schedule is Section 40 27 00, Process Piping – General for process fluid designation. 2) As required by equipment manufacturer. | | | | | | | |

SECTION 40 42 13
PROCESS PIPING INSULATION

PART 1 GENERAL

1.01 REFERENCES

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

1. American Society of Heating, Refrigerating and Air Conditioning Engineers Inc. (ASHRAE): 90.1, Energy Standard for Buildings Except Low-Rise Residential Buildings.
2. ASTM International (ASTM):
 - a. B209, Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
 - b. C165, Standard Test Method for Measuring Compressive Properties of Thermal Insulations.
 - c. C177, Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus.
 - d. C518, Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.
 - e. C534/C534M, Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form.
 - f. C547, Standard Specification for Mineral Fiber Pipe Insulation.
 - g. C552, Standard Specification for Cellular Glass Thermal Insulation.
 - h. C585, Standard Practice for Inner and Outer Diameters of Thermal Insulation for Nominal Sizes of Pipe and Tubing.
 - i. C1136, Standard Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation.
 - j. C1729, Standard Specification for Aluminum Jacketing for Insulation.
 - k. E84, Standard Test Method for Surface Burning Characteristics of Building Materials.
 - l. E96/E96M, Standard Test Methods for Water Vapor Transmission of Materials.
3. International Code Council (ICC): International Energy Conservation Code (IECC).
4. Underwriters Laboratories Inc. (UL).

1.02 SUBMITTALS

- A. Action Submittals: Manufacturer's descriptive literature.
- B. Informational Submittals: Maintenance information.

PART 2 PRODUCTS

2.01 PIPE AND FITTING INSULATION

- A. Type 1—Elastomeric:
 - 1. Material: Flexible elastomeric pipe insulation, closed-cell structure in accordance with ASTM C534/C534M.
 - 2. Temperature Rating: Minus 297 degrees F to 220 degrees F.
 - 3. Nominal Density: 3 pcf to 6 pcf.
 - 4. Conductivity in accordance with ASHRAE 90.1 and maximum numerical value of 0.25 Btu-in./hr-square foot degrees F at 75 degrees F per ASTM C177 or ASTM C518.
 - 5. Maximum water vapor transmission of 0.06 perm-inch per ASTM E96/E96M, Procedure A.
 - 6. Joints: Manufacturer's adhesive.
 - 7. Flame Spread Rating: Less than 25 per ASTM E84.
 - 8. Smoke Developed Index: Less than 50 per ASTM E84.
 - 9. Manufacturers and Products:
 - a. Nomaco; K-Flex.
 - b. Armacell; AP Armaflex.
- B. Type 2—Fiberglass:
 - 1. Material: UL rated, preformed, sectional bonded fiberglass per ASTM C585 with factory applied, Kraft paper with aluminum foil vapor barrier jacket with pressure-sensitive, self-sealing lap.
 - 2. Insulation Temperature Rating: Zero to 850 degrees F.
 - 3. Conductivity in accordance with ASHRAE 90.1 and maximum numerical value of 0.23 Btu-in./hr-square foot degrees F at 75 degrees F.
 - 4. Jacketing per ASTM C1136 with minimum water vapor transmission for jacket of 0.02 perm-inch per ASTM E96/E96M. Furnish with no jacket if field finish system specified.
 - 5. Joints: Matching pressure-sensitive butt strips for sealing circumferential joints.
 - 6. Flame Spread Rating: Less than 25 per ASTM E84.
 - 7. Smoke Developed Index: Less than 50 per ASTM E84.
 - 8. Manufacturers and Products:
 - a. Owens Corning Fiberglass; ASJ/SSL-11.
 - b. John Manville; Micro-Lok with Jacket.

C. Type 3—Foamglass:

1. Material: Cellular glass per ASTM C552.
2. Nominal Density: 7.5 pcf.
3. Compressive Strength: 90 psi per ASTM C165.
4. Temperature Rating: Minus 290 degrees F to 900 degrees F.
5. Conductivity in accordance with ASHRAE 90.1 and maximum numerical value of 0.29 Btu-in./hr-square foot degrees F.
6. Minimum water vapor transmission for insulation of 0.00 perm-inch per ASTM E96/E96M.
7. Joints: Matching pressure-sensitive butt strips for sealing circumferential joints.
8. Flame Spread Rating: 0 per ASTM E84.
9. Smoke Developed Index: 0 per ASTM E84.
10. Follow manufacturer's recommendation, based upon temperature of piping to be insulated.
11. Manufacturer and Product: Pittsburgh Corning; Foamglas One.

2.02 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 04, Painting.

C. Type F3—Aluminum:

1. Aluminum Roll Jacketing: For straight run piping, wrought aluminum Alloy 3003, 5005, 1100, or 3105 to ASTM B209 with H-14 temper, in accordance with ASTM C1729, minimum 0.016-inch thickness, with smooth mill finish.
2. Vapor Barrier: Provide factory applied vapor barrier, heat and pressure bonded to inner surface of aluminum jacketing.
3. Fitting Covers: Material as for aluminum roll jacketing, premolded, one or two piece covers, which includes elbows, tee/valves, end caps, mechanical line couplings, and specialty fittings.
4. Manufacturers:
 - a. RPR Products; Insul-Mate.
 - b. ITW, Pabco-Childers.

D. Type F4—Foamglass Jacketing:

1. Type 3 Insulation—Buried and Up to 1 Foot Above Grade: 70-mil bituminous resin with woven, glass fabric, aluminum foil layer, and plastic film coating, self-sealing manual pressure seals; Pittsburgh Corning Pittwrap SS.
2. Type 3 Insulation—Greater than 1 Foot Above Grade: 30-mil modified bituminous membrane with self-sealing manual pressure seals; Pittsburgh Corning Pittwrap CW30.

PART 3 EXECUTION**3.01 APPLICATION****A. General:**

1. Insulate valve bodies, flanges, and pipe couplings.
2. Insulate and vapor seal hangers, supports, anchors, and other piping appurtenances that are secured directly to cold surfaces.
3. Do not insulate flexible pipe couplings and expansion joints.
4. Service and Insulation Thickness: Refer to Supplement Service and Insulation Thickness table following “End of Section” and to Piping Schedule in Section 40 27 00, 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 04, Painting.
 - 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 | | | | | | | | |
|---|---|--|--------------------------------|---|---------------------|----------------------------|----------|--------|
| Service Type | Pipe Legend | Thickness | Fluid Temperature (degrees F)* | Insulation | Finish Systems | | | |
| | | | | | Concealed from View | Indoors Exposed | Outdoors | Buried |
| HT-Piping requiring heat tracing. | See Section 40 05 33, Heat Tracing for pipes with heat trace. | Pipe Size: Insulation Thickness Inches:** 1/4-3: 1 3.5-10: 1.5 12-16: 2 18-24: 2.5 | 50 to 100 | Type 2 Insulate and heat trace outside lines 1' above grade. Use Type 3 Insulation from 1' above grade to frost depth and for insulation within below-grade vaults. | None | F3 unless otherwise noted. | F3 | NA |
| <p>*Use these fluid temperatures unless otherwise noted in the Piping Schedule.</p> <p>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.</p> | | | | | | | | |

SECTION 40 80 01
PROCESS PIPING LEAKAGE TESTING

PART 1 GENERAL

1.01 REFERENCES

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

1. Chlorine Institute (2001 L Street N.W., Washington D.C. 28036):
Pamphlet 6, Piping Systems for Dry Chlorine.

1.02 SUBMITTALS

A. Informational Submittals:

1. Testing Plan: Submit prior to testing and include at least the information that follows.
 - a. Testing dates.
 - b. Piping systems and section(s) to be tested.
 - c. Test type.
 - d. Method of isolation.
 - e. 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.
- D. Gravity Piping:
1. Perform testing after service connections, manholes, and backfilling have been completed between stations to be tested.
 2. Determine groundwater level at time of testing by exploratory holes or other method acceptable to Engineer.

3.02 HYDROSTATIC TEST FOR PRESSURE PIPING

- A. Fluid: Clean water of such quality to prevent corrosion of materials in piping system.
- B. Exposed Piping:
1. Perform testing on installed piping prior to application of insulation.
 2. Maximum Filling Velocity: 0.25 foot per second, applied over full area of pipe.
 3. Vent piping during filling. Open vents at high points of piping system or loosen flanges, using at least four bolts, or use equipment vents to purge air pockets.
 4. Maintain hydrostatic test pressure continuously for 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:

$$L = \frac{SD(P)^{1/2}}{133,200}$$

where:

- L = Allowable leakage, in gallons per hour.
- S = Length of pipe tested, in feet.
- D = Nominal diameter of pipe, in inches.
- P = Test pressure during leakage test, in pounds per square inch.

7. Correct leakage greater than allowable, and retest as specified.

3.03 HYDROSTATIC TEST FOR GRAVITY PIPING

- A. Testing Equipment Accuracy: Plus or minus 1/2-gallon water leakage under specified conditions.
- B. Maximum Allowable Leakage: 0.16 gallon per hour per inch diameter per 100 feet. Include service connection footage in test section, subjected to minimum head specified.
- C. Defective Piping Sections: Replace or test and seal individual joints, and retest as specified.

3.04 FIELD QUALITY CONTROL

- A. Test Report Documentation:
 1. Test date.
 2. Description and identification of piping tested.
 3. Test fluid.
 4. Test pressure.
 5. Remarks, including:
 - a. Leaks (type, location).
 - b. Repair/replacement performed to remedy excessive leakage.
 6. Signed by Contractor and Engineer to represent that test has been satisfactorily completed.

END OF SECTION

SECTION 40 90 01
INSTRUMENTATION AND CONTROL FOR PROCESS SYSTEMS

PART 1 GENERAL

1.01 REFERENCES

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

1. ASTM International (ASTM):
 - a. A182, Standard Specification for Forged or Rolled Alloy-Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service.
 - b. A276, Standard Specification for Stainless and Heat-Resisting Steel Bars and Shapes.
 - c. A312, Standard Specification for Seamless and Welded Austenitic Stainless Steel Pipes.
 - d. B32, Standard Specification for Solder Metal.
 - e. B88, Standard Specification for Seamless Copper Water Tube.
2. International Society of Automation (ISA):
 - a. S5.1, Instrumentation Symbols and Identification (NRC ADOPTED).
 - b. PR12.6, Installation of Intrinsically Safe Systems for Hazardous (Classified) Locations.
 - c. S5.4, Standard Instrument Loop Diagrams.
 - d. S20, Specification Forms for Process Measurement and Control Instruments, Primary Elements and Control Valves.
 - e. S50.1, Compatibility of Analog Signals for Electronic Industrial Process Instruments.
3. National Electrical Manufacturers Association (NEMA):
 - a. 250, Enclosures for Electrical Equipment (1,000 Volts Maximum).
 - b. ICS 1, General Standards for Industrial Control and Systems.
4. National Institute of Standards and Technology (NIST).
5. NSF International (NSF):
 - a. NSF/ANSI 61, Drinking Water System Components - Health Effects.
 - b. NSF/ANSI 372, Drinking Water System Components - Lead Content.
6. Underwriters Laboratory, Inc. (UL): 508A, Standard for Safety, Industrial Control Panels.

1.02 SUMMARY

A. Work Includes:

1. Engineering, furnishing, installing, calibrating, adjusting, testing, documenting, starting up, and Owner training for complete Process Instrumentation and Control (PIC) for plant.
2. Major parts are:
 - a. Primary elements, transmitters, control devices and control panels.
 - b. Addition of one new PLC control panel (CP-680) at the Crosstown facility 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 built to maximize available I/O.
 - c. Integration of vendor provided PLC based Lime Feed systems at both sites into the existing plant control systems.
 - d. Integration of new systems and controls into existing Wonderware HMI systems at both sites. 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.
 - e. Application software shall be provided by the Contractor. Work includes but is not limited to, programming of the new PLC provided under this section 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. M/R Systems, Norcross, GA.
2. Revere Control Systems, Birmingham, AL.
3. J.K. Duren Company, Roswell, GA.
4. 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.
 - 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. |
| 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 grooves that penetrate wire strands providing a vibration-proof connection.
 - 3) Guides strands of wire into terminal.
 - c. Screws: Hardened steel, captive and self-locking.
 - d. Current Bar: Copper or treated brass.
 - e. Insulation:
 - 1) Thermoplastic rated for minus 55 to plus 110 degree C.
 - 2) Two funneled shaped inputs to facilitate wire entry.
 - f. Mounting:
 - 1) Standard DIN rail.
 - 2) Terminal block can be extracted from an assembly without displacing adjacent blocks.
 - 3) End Stops: Minimum of one at each end of rail.
 - g. Wire preparation: Stripping only permitted.
 - h. Jumpers: Allow jumper installation without loss of space on terminal or rail.
 - i. Marking System:
 - 1) Terminal number shown on both sides of terminal block
 - 2) Allow use of preprinted and field marked tags.
 - 3) Terminal strip numbers shown on end stops.
 - 4) Mark terminal block and terminal strip numbers as shown on Panel Control Diagrams and Loop Diagrams.
 - 5) Fuse Marking for Fused Terminal Blocks: Fuse voltage and amperage rating shown on top of terminal block.

3. Terminal Block, General-Purpose:
 - a. Rated Voltage: 600V ac.
 - b. Rated Current: 30 amp.
 - c. Wire Size: 22 AWG to 10 AWG.
 - d. Rated Wire Size: 10 AWG.
 - e. Color: Grey body.
 - f. Spacing: 0.25 inch, maximum.
 - g. Test Sockets: One screw test socket 0.079-inch diameter.
 - h. Manufacturer and Product: Entrelec; Type M4/6.T.
4. Terminal Block, Ground:
 - a. Wire Size: 22 AWG to 12 AWG.
 - b. Rated Wire Size: 12 AWG.
 - c. Color: Green and yellow body.
 - d. Spacing: 0.25 inch, maximum.
 - e. Grounding: Ground terminal blocks electrically grounded to the mounting rail.
 - f. Manufacturer and Product: Entrelec; Type M4/6.P.
5. Terminal Block, Fused, 24V dc:
 - a. Rated Voltage: 600V dc.
 - b. Rated Current: 16-amp.
 - c. Wire Size: 22 AWG to 10 AWG.
 - d. Rated Wire Size: 10 AWG.
 - e. Color: Grey body.
 - f. Fuse: 0.25 inch by 1.25 inches.
 - g. Indication: LED diode 24V dc.
 - h. Spacing: 0.512 inch, maximum.
 - i. Manufacturer and Product: Entrelec; Type M10/13T.SFL.
6. Terminal Block, Fused, 120V ac:
 - a. Rated Voltage: 600V ac.
 - b. Rated Current: 16-amp.
 - c. Wire Size: 22 AWG to 10 AWG.
 - d. Rated Wire Size: 10 AWG.
 - e. Color: Grey body.
 - f. Fuse: 0.25 inch by 1.25 inches.
 - g. Indication: Neon Lamp 110V ac.
 - h. Leakage Current: 1.8 mA, maximum.
 - i. Spacing: 0.512 inch, maximum
 - j. Manufacturer and Product: Entrelec; Type M10/13T.SFL.

F. Grounding of Enclosures:

1. Furnish isolated copper grounding bus for signal and shield ground connections.
2. Ground bus grounded at a common signal ground point in accordance with National Electrical Code requirements.

3. Single Point Ground for Each Analog Loop:
 - a. Locate at dc power supply for loop.
 - b. Use to ground wire shields for loop.
 4. Ground terminal block rails to ground bus.
- G. Analog Signal Isolators: Furnish signal isolation for analog signals that are sent from one enclosure to another. Do not wire in series instruments on different panels, cabinets, or enclosures.
- H. Power Distribution Within Panels:
1. Feeder Circuits:
 - a. One or more 120V ac, 60-Hz feeder circuits as shown on Drawings.
 - b. Make provisions for feeder circuit conduit entry.
 - c. Furnish terminal board for termination of wires.
 2. Power Panel: Furnish main circuit breaker and a circuit breaker on each individual branch circuit distributed from power panel.
 - a. Locate to provide clear view of and access to breakers when door is open.
 - b. Breaker Sizes: Coordinate such that fault in branch circuit will blow only branch breaker but not trip the main breaker.
 - 1) Branch Circuit Breaker: 15 amps at 250V ac.
 - c. Breaker Manufacturers and Products: Refer to Division 26, Electrical.
 3. Circuit Wiring: P&IDs and Control Diagrams on Drawings show function only. Use following rules for actual circuit wiring:
 - a. Devices on Single Circuit: 20, maximum.
 - b. Multiple Units Performing Parallel Operations: To prevent failure of any single branch circuit from shutting down entire operation, do not group all units on same branch circuit.
 - c. Branch Circuit Loading: 12 amperes continuous, maximum.
 - d. Panel Lighting and Service Outlets: Put on separate 15-amp, 120V ac branch circuit.
 - e. Provide 120V ac plugmold for panel components with line cords.
- I. Signal Distribution:
1. Within Panels: 4 mA to 20 mA dc signals may be distributed as 1 to 5V dc.
 2. Outside Panels: Isolated 4 mA to 20 mA dc only.
 3. All signal wiring twisted in shielded pairs.

J. Relays:

1. General:
 - a. Relay Mounting: Plug-in type socket.
 - b. Relay Enclosure: Furnish dust cover.
 - c. Socket Type: Screw terminal interface with wiring.
 - d. Socket Mounting: Rail.
 - e. Provide holddown clips.
2. Signal Switching Relay:
 - a. Type: Dry circuit.
 - b. Contact Arrangement: 2 Form C contacts.
 - c. Contact Rating: 0 to 5 amps at 28V dc or 120V ac.
 - d. Contact Material: Gold or silver.
 - e. Coil Voltage: As noted or shown.
 - f. Coil Power: 0.9 watts (dc), 1.2VA (ac).
 - g. Expected Mechanical Life: 10,000,000 operations.
 - h. Expected Electrical Life at Rated Load: 100,000 operations.
 - i. Indication Type: Neon or LED indicator lamp.
 - j. Seal Type: Hermetically sealed case.
 - k. Manufacturer and Product: Potter and Brumfield; Series KH/KHA.
3. Control Circuit Switching Relay, Nonlatching:
 - a. Type: Compact general-purpose plug-in.
 - b. Contact Arrangement: 3 Form C contacts.
 - c. Contact Rating: 10A at 28V dc or 240V ac.
 - d. Contact Material: Silver cadmium oxide alloy.
 - e. Coil Voltage: As noted or shown.
 - f. Coil Power: 1.8 watts (dc), 2.7VA (ac).
 - g. Expected Mechanical Life: 10,000,000 operations.
 - h. Expected Electrical Life at Rated Load: 100,000 operations.
 - i. Indication Type: Neon or LED indicator lamp.
 - j. Push to test button.
 - k. Manufacturer and Product: Potter and Brumfield; Series KUP.

K. Power Supplies:

1. Furnish to power instruments requiring external dc power, including two-wire transmitters and dc relays.
2. Convert 120V ac, 60-Hz power to dc power of appropriate voltage(s) with sufficient voltage regulation and ripple control to assure that instruments being supplied can operate within their required tolerances.
3. Provide output over voltage and over current protective devices to:
 - a. Protect instruments from damage due to power supply failure.
 - b. Protect power supply from damage due to external failure.
4. Enclosures: NEMA 1 in accordance with NEMA 250.

5. Mount such that dissipated heat does not adversely affect other components.
6. Fuses: For each dc supply line to each individual two-wire transmitter.
 - a. Type: Indicating.
 - b. Mount so fuses can be easily seen and replaced.

L. Internal Panel Lights for Freestanding Panels:

1. Type: Switched 100-watt incandescent back-of-panel lights.
2. Quantity: One light for every 4 feet of panel width.
3. Mounting: Inside and in the top of back-of-panel area.
4. Protective metal shield for lights.

M. Service Outlets for Freestanding Panels:

1. Type: Three-wire, 120-volt, 15-ampere, GFCI duplex receptacles.
2. Quantity:
 - a. For panels 4 feet wide and smaller: One.
 - b. For panels wider than 4 feet: One for every 4 feet of panel width, two minimum per panel.
3. Mounting: Evenly spaced along back-of-panel area.

N. Internal Panel Lights and Service Outlets for Smaller Panels:

1. Internal Panel Light: Switched 100-watt incandescent light.
2. Service Outlet: Breaker protected 120-volt, 15-amp, GFCI duplex receptacle:
3. Required for all following panels:

O. Standard Pushbutton Colors and Inscriptions: Use following color code and inscriptions for pushbuttons, unless otherwise noted on Drawings.

| Tag Function | Inscription(s) | Color |
|---------------------|-----------------------|-------------------------|
| OO | ON OFF | Black Black |
| OC | OPEN CLOSE | Black Black |
| OCA | OPEN CLOSE AUTO | Black Black Black |
| OOA | ON OFF AUTO | Black Black Black |

| Tag Function | Inscription(s) | Color |
|---------------------|-----------------------|----------------|
| 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 Freedom One Riser Cables.
 - b. Corning Freedom 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 |
|---------------------------|---|---------------------|
| Annunciator light bulbs | 20 | 10 |
| Annunciator window module | 10 | 5 |
| 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. Nonventilated 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. Nonfreestanding 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 assemblies, and field mounted analog transmitters and receivers.
 - b. At the field and panel, console, or assembly connection of signal circuits that have portions of the circuit extending outside of a protective building.
3. Construction: First-stage high energy metal oxide varistor and second-stage bipolar silicon avalanche device separated by series impedance. Includes grounding wire, stud, or terminal.
4. Response: 5 nanoseconds maximum.
5. Recovery: Automatic.
6. Temperature Range: Minus 20 degrees C to plus 85 degrees C.

B. Suppressors on 120V ac Power Supply Connections:

1. Occurrences: Tested and rated for a minimum of 50 occurrences of IEEE 587 Category B test waveform.
2. First-Stage Clamping Voltage: 350 volts or less.
3. Second-Stage Clamping Voltage: 210 volts or less.

4. Continuous Operation: Power supplies for one four-wire transmitter or receiver: 5 amps minimum at 130V ac. All other applications: 30 amps minimum at 130V ac.

C. Suppressors on Analog Signal Lines:

1. Test Waveform: Linear 8 microsecond rise in current from 0 amps to a peak current value followed by an exponential decay of current reaching one half the peak value in 20 microseconds.
2. Surge Rating: Tested and rated for 50 occurrences of 2,000-amp peak test waveform.
 - a. dc Clamping Voltage: 20 to 40 percent above operating voltage for circuit.
 - b. dc Clamping Voltage Tolerance: Less than plus or minus 10 percent.
 - c. Maximum Loop Resistance: 18 ohms per conductor.

D. Physical Characteristics:

1. Mounted in Enclosures: Encapsulated 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:
 - a. 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 μ m | 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 04, Painting (Condensed).

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. L5 Level Element and Transmitter, Ultrasonic:

1. General:
 - a. Function: Continuous, noncontacting level measurement.
 - b. Type: Ultrasonic.
 - c. Parts: Element, transmitter, interconnecting cable, and accessories as noted.
2. Service:
 - a. Application: Chemical Storage Tanks; refer to instrument list for details.
 - b. Vapor Space Pressure: Atmospheric, unless otherwise noted.
 - c. Operating Temperature Range:
 - 1) Element: Minus 4 degrees F to plus 149 degrees F.
 - 2) Transmitter: Minus 4 degrees F to 113 degrees F.
3. Performance:
 - a. Range: As noted.
 - b. Zero Reference: As noted.
 - c. Accuracy: Plus or minus 0.25 percent of maximum range or 6 mm, whichever is greater.
 - d. Resolution: 0.1 percent of range or 2 mm, whichever is greater.
 - e. Blanking Distance: Sensor dependent, typically 1 foot.
4. Element:
 - a. NEMA 6P waterproof.
 - b. Housing: PVDF, unless otherwise noted.
 - 1) Other materials subject to Engineer approval.
 - c. Facing: Teflon.
 - d. Integral Flange: If noted.
 - 1) Face: PTFE, unless otherwise noted.
 - 2) Size: 8 inches.
 - e. Process Connection:
 - 1) 1-inch NPT, unless otherwise noted.
 - 2) Top mounted.
 - f. Electrically Hazardous Rating:
 - 1) Class I, Div 1, Groups A, B, C, and D: If noted.
 - 2) Class II, Div 1, Groups E, F, and G: If noted.
 - 3) Other Ratings: As noted.
 - g. Beam Angle: 12 degrees or less.
 - h. Integral temperature compensation.
5. Transmitter:
 - a. Display.
 - b. Integral keypad or nonintrusive external programming.
 - c. Enclosure: NEMA 4X polycarbonate, unless otherwise noted.
 - d. Power Supply: 115 volts, 50/60-Hz, unless otherwise noted.

- e. Isolated Analog Output:
 - 1) One Minimum: 4 mA to 20 mA dc for load impedance of 0 to 750 ohms.
- f. Digital Communication: As noted.
- g. Discrete Outputs:
 - 1) Minimum, two relay (SPDT) rated for 2 amps continuous at 230V ac.
 - 2) Assignable and as noted.
- 6. Interconnecting Cable: Weatherproof, UV protected, length as required, and type as recommended by manufacturer.
- 7. Accessories:
 - a. Submergence Shield: If noted.
 - b. Remote Programming Software: If noted.
 - 1) Allows remote programming via computer and echo traces for troubleshooting.
 - 2) One per lot of units furnished.
 - c. Others: As noted.
 - d. If no integral keypad, furnish one handheld programmer per lot of units furnished.
- 8. Manufacturers and Products:
 - a. Siemens; SITRANS L, Model HydroRanger 200 and Sensor.
 - b. Pulsar; Blackbox Series 13X and Sensor.
 - c. Endress & Hauser; Model FMU90 and Sensor.

B. L18 Level Switch, Non-Mercury:

- 1. General:
 - a. Function: Actuate contact at preset liquid level.
 - b. Type:
 - 1) Direct-acting, stainless steel float with enclosed, encapsulated switch and integral cable.
 - 2) Mercury free.
- 2. Service (Liquid): As noted.
- 3. Performance:
 - a. Setpoint: As noted.
 - b. Differential: 8 inches maximum.
 - c. Temperature: 32 degrees F (nonfreezing) to 160 degrees F.
- 4. Features:
 - a. Entire Assembly: Watertight and impact-resistant.
 - b. Float
 - 1) Material and Size: 5.5-inch diameter polymer-coated, Type 316 stainless steel float.
 - 2) Buoyancy: 2 pounds.
 - c. Cable:
 - 1) Length as noted or as necessary per mounting requirements.

- 2) Plastic-jacketed cable, oil-resistant and suitable for continuous service.
 - d. Mounting:
 - 1) Anchor Mounting Kit:
 - a) 15-pound vinyl-coated cast-iron anchor.
 - b) 1/8-inch, Type 316 stainless steel wire rope.
 - c) Stainless steel cable clips.
 - 5. Signal Interface:
 - a. Switch Type: Magnetic reed.
 - b. Switch Contacts:
 - 1) Isolated, rated at least 0.8 amp continuous at 120V ac.
 - 2) Contact Type: Either NO or NC, as required by application or as noted; or SPDT (NO and NC).
 - 6. Accessories: As noted.
 - 7. Manufacturers and Products:
 - a. Siemnes Water Technologies; Model 9G-EF Direct Acting Float Switch (B100).
 - b. Contegra; Model FS90.
- C. P4 Pressure Gauge:

- 1. General:
 - a. Function: Local pressure indication.
 - b. Type: Bourdon tube element.
- 2. Performance:
 - a. Scale Range: As noted.
 - b. Accuracy: Plus or minus 0.50 percent of full scale.
- 3. Features:
 - a. Dial: 4-1/2-inch diameter.
 - b. Pointer Vibration Reduction: Required, unless otherwise noted. Use the following method.
 - 1) Liquid filled gauge front, unless otherwise noted.
 - a) Glycerine fill, unless otherwise noted.
 - c. Case Material: Black thermoplastic, unless otherwise noted.
 - d. Materials of Wetted Parts (including element, socket/process connection, throttling device (if specified) and secondary components):
 - 1) Stainless steel, unless otherwise noted.
 - e. Pointer: Adjustable by removing ring and window.
 - f. Window: Glass or acrylic, unless otherwise noted.
 - g. Threaded reinforced polypropylene front ring.
 - h. Case Type: Solid front with blow-out back.
- 4. Process Connection:
 - a. Mounting: Lower stem, unless otherwise noted.
 - b. Size: 1/2-inch MNPT, unless otherwise noted.

5. Accessories:
 - a. Throttling Device: Required, unless otherwise noted.
 - 1) Type suitable for the intended service.
 - 2) Install in gauge socket bore.
6. Manufacturers and Products:
 - a. Ashcroft; Duragauge Model 1259/Model, 1279/Model, 1279 PLUS!
 - b. Ametek U.S. Gauge; Solfrunt Model 19XX/1981Advantatge.
 - c. WIKA, Type 2XX.34.

D. P6 Pressure Seal, Diaphragm:

1. General:
 - a. Function: Isolate sensing element from process fluid.
 - b. Type:
 - 1) Diaphragm.
 - 2) Fluid filled between diaphragm and sensing element.
2. Service:
 - a. Pressure: Same as associated sensor.
 - b. Temperature Range: If noted.
3. Performance:
 - a. Pressure:
 - 1) For threaded process connections, at least 2,500 psig at 100 degrees F.
 - 2) Glycerin Fill: Suitable only for pressure (not vacuum applications).
 - b. Temperature:
 - 1) Dependent upon fill fluid.
 - a) Glycerin (food grade): Zero to 400 degrees F.
 - b) Silicone: Minus 40 degrees F to plus 600 degrees F.
 - c) Silicone (food grade): Zero to 375 degrees F.
 - d) Halocarbon: Minus 70 degrees F to 300 degrees F.
4. Features:
 - a. Materials:
 - 1) Lower Housing: Type 316 stainless steel, unless otherwise noted.
 - 2) Diaphragm Material: Type 316 stainless steel, unless otherwise noted.
 - 3) Top Housing: Steel, unless otherwise noted.
 - b. Diaphragm: Welded to upper housing, unless otherwise noted.
 - c. Filling screw in upper housing.
 - d. Fill Fluid:
 - 1) Silicone (food grade).
 - 2) Factory assembled and filled.
 - e. Flushing Connection: 1/4-inch NPT in lower housing.

- f. Diaphragm Seal Displacement: 0.1 cubic inch, nominal.
 - 5. Connections:
 - a. Instrument: 1/2-inch female NPT, unless otherwise noted or shown.
 - b. Process: 1/2-inch female NPT, unless otherwise noted or shown.
 - 6. Manufacturers:
 - a. Ashcroft; Type 201.
 - b. Ametek; Mansfield and Green Division; Type SG.
 - c. WIKA; Type L990.10.
- E. P9 Pressure Transmitter:
- 1. General:
 - a. Function: Measure pressure and transmit signal proportional to pressure.
 - 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.
 - 2) Accuracy: Plus or minus 0.075 percent of span, unless otherwise noted.
 - b. Ambient Operating Temperature: Minus 40 degrees F to plus 175 degrees F, with integral meter.
 - c. Process Operating Temperature: Minus 40 degrees F to plus 250 degrees F.
 - d. Humidity: 0 to 100 percent relative humidity.
 - e. Hazardous Location Certifications: If and as noted.
 - 3. Features:
 - a. Type: Gauge pressure, unless otherwise noted.
 - b. Adjustable damping.
 - c. LCD indicator, unless otherwise noted.
 - 1) Display in either percent or engineering units, field configurable.
 - d. Wetted Metallic Parts: Type 316 stainless steel, unless otherwise noted.
 - 1) Includes drain/vent valves; process flanges and adapters, and process isolating diaphragm.
 - e. Wetted-Rings: Glass filled TFE, graphite filled PTFE, or Viton, unless otherwise noted.

- f. Bolts and Nuts (if required): Type 316 stainless steel, unless otherwise noted.
 - g. 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. 4mA 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.
 - 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. Two-valve (isolate and vent) Stainless Steel Manifold.
 - 8. Manufacturers and Products:
 - a. Gauge Pressure Units:
 - 1) Rosemount; Model 3051 TG.
 - 2) Foxboro; Model IGP20.
 - 3) Owner Approved Equal.

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. |
| CP-680 | N/A | PLC Control Panel | NEMA 4X 316SS Dimensions: 4'H x 3'W x 1'D | 10-N-02 | 0059-080 | |
| CT-LI/LIT-682-1 | L5 | Level Element and Transmitter: Ultrasonic | Range: 0-6 FT | 10-N-02 | 4091-252 0559-080 | CP-680 |
| CT-LI/LIT-682-2 | L5 | Level Element and Transmitter: Ultrasonic | Range: 0-6 FT | 10-N-02 | 4091-252 0559-080 | CP-680 |
| CT-PE-686-1 | P6 | Pressure Seal, Diaphragm | Process Fluid: Sodium Permanganate Lower Housing: Titanium Diaphragm Material: Titanium | 10-N-02 | 4091-304B 4091-305A | |
| CT-PI-686-1 | P4 | Pressure Gauge | Range: 0 – 100 PSIG | 10-N-02 | 4091-304B 4091-305A | |
| CT-PE-686-2 | P6 | Pressure Seal, Diaphragm | Process Fluid: Sodium Permanganate Lower Housing: Titanium Diaphragm Material: Titanium | 10-N-02 | 4091-304B 4091-305A | |
| CT-PI-686-2 | P4 | Pressure Gauge | Range: 0 – 100 PSIG | 10-N-02 | 4091-304B 4091-305A | |

LOOP SPECIFICATION

FORMAT

The loop specifications are divided into the following sections:

Function Definitions: This section defines various functions used in subsequent sections.

Required Global Functions: These functions are required for all identified variables, and thus are not included in the subsequent Unit Process Loop Specifications.

Modular Functions: For functions used repetitively, modular functions have been developed and are used in the specific Unit Process Descriptions.

Unit Processes: Loop specifications for each specific Unit Process are described. These descriptions include extensive use of referenced Modular Functions.

- **FUNCTION DEFINITIONS**

Pump Run Fail: A pump is commanded-to-run from the PMCS, but is not confirmed running within a preset time. Unless otherwise noted, running is confirmed by receiving an ON status M-contact from the pump's starter or adjustable speed drive.

Open Fail: A valve is commanded-to-open from the PMCS, but is not confirmed open within a preset time. Unless otherwise noted, a valve is confirmed open by receiving OPEN limit switch contact from the valve.

Close Fail: A valve is commanded-to-close from the PMCS, but is not confirmed closed within a preset time. Unless otherwise noted, a valve is confirmed closed by receiving Close limit switch contact from the valve.

Position Fail: A modulating valve is commanded to a set point position from the PMCS, but the valve is not confirmed to be within a preset percentage of set point within a preset time. This function requires that modulating valve is furnished with a position transmitter, which sends position signal back to PMCS.

Totalize Flow: Integrate flow rate with respect to time. Unless otherwise noted, operator shall be able to reset totalized value to zero, but reset function shall be password protected.

Start: Issue a maintained Run command. Controlled device shall run as long as the Run command signal is present. On absence of Run command, immediately ceases operation.

Stop: Cease the maintained Run command.

Elapsed Run Time: Calculate total time (in tenths of an hour) a device has been in operation. For constant speed pumps, use starter M-contacts to detect when the pump is in operation. For adjustable speed pumps, use ON status contacts from the drive that closes when the drive is in operation. Unless otherwise noted, operator shall be able to reset elapsed run time to zero, but reset function shall be password protected.

Cycle Count: Count the number of cycles a piece of equipment undergoes. One cycle is defined as the transition from OFF to ON. For valves, one cycle is defined from one Closed status event to the next.

REQUIRED GLOBAL FUNCTIONS

1. Calculate and display elapsed run time of each pump whose ON status is displayed by the PMCS System.
2. Calculate and display Cycle Counts of each pump whose ON status is displayed by the PMCS System.
3. Trend each process variable which has a PLC analog input.
4. If shown under PMCS discrete displays, derive HIGH and LOW alarms from the associated process variable.
5. Totalize flow rate of each flow rate analog input.
6. Bumpless Transfer: For the PLC/PMCS System, configure all “software” Manual/Auto switches so they provide “bumpless transfer.”
 - a. Manual to Auto Transition: Once the transition occurs, immediately run the device if the Auto Mode so commands.
 - b. Auto to Manual Transition:
 - 1) If a device has been running in Auto, configure so it continues to run once placed in Manual.
 - 2) If a device has not been running in Auto, configure so it does not run once placed in Manual.
 - 3) If an adjustable speed device has been running at a certain speed in Auto, configure so it runs at the same speed once placed in Manual.

MODULAR FUNCTIONS (Implement if noted in the specific unit process loop specifications)

Modular Function: Field Alarm

PMCS Display and Control Functions

Field Alarm

- Display flashing yellow when Field Alarm True and Unacknowledged
- Display steady yellow when Field Alarm True and Acknowledged
- Display ceases when Field Alarm False and Acknowledged

Modular Function: Field Condition Status

PMCS Discrete Display

Field Condition Status (see specific loop to identify specific field condition)

Modular Function: Flow

PMCS Discrete Display

High Flow Alarm

Low Flow Alarm

PMCS Value Displays

Flow Rate

Total Flow, Daily

Total Flow, Monthly

PMCS Trends

See Global Functions

Modular Function: Flow Pacing

PMCS Discrete Displays

PMCS Value Displays

Active Substance Required (Dosage Set Point X Process Flow)

Process Flow

Dosage Set Point

PMCS Trends

PMCS Display and Control Functions

Provide flow pacing of the controlled equipment, including manual dosage adjustment

Modular Function: Level

PMCS Discrete Display

High Level Alarm

Low Level Alarm

PMCS Value Displays

Level Rate

Total Level, Daily

Total Level, Monthly

PMCS Trends

See Global Functions

Modular Function: Open/Close Valve Operation

PMCS Discrete Displays

Open Status

Closed Status

Open Fail

Close Fail

Valve under PMCS control (Field Hand Switch in Remote)

PMCS Value Display

Cycle Counter; display last 24 hours; see Global Functions

PMCS Display and Control Functions

Provide MANUAL/OFF/AUTO control of Valve

- In MANUAL, provide Open/Close control
- In AUTO, provide control as per individual Unit Process Loop Specifications

Modular Function: PressurePMCS Discrete Display

High Pressure Alarm

Low Pressure Alarm

PMCS Value Displays

Pressure Rate

Total Pressure, Daily

Total Pressure, Monthly

PMCS Trends

See Global Functions

Modular Function: RUN CommandPMCS Discrete Display

ON Status

Pump Run Fail

Pump under PMCS Control (Field Hand Switch in Remote)

PMCS Value Display

Elapsed Run Time; display last 24 hours; see Global Functions

Cycle Counter; display last 24 hours; see Global Functions

PMCS Display and Control Functions

Provide MANUAL/OFF/AUTO control of Pump

- In MANUAL, provide Start/Stop control.
- In AUTO, provide control as per individual Unit Process Loop Specifications.

Enable the above control only if the Pump is under PMCS control

Also, enable the Pump Run Fail only if the Pump is under PMCS control

Modular Function: RUN Status

PMCS Discrete Display

ON Status

Pump Run Fail

Pump under PMCS Control (Field Hand Switch – if provided - in Remote).

PMCS Value Display

Elapsed Run Time; display last 24 hours; see Global Functions.

Cycle Counter; display last 24 hours; see Global Functions.

Unit Process 65: Liquid Lime Feed and Storage

(NOTE: The following loop description is applicable to both the Crosstown and South Fayette facilities. Differentiation of the flow pacing sources for each site is noted below.)

The Liquid Lime Storage and Feed system is controlled by a vendor provided PLC based control panel. This panel will interface to the PICS provided PMCS through Ethernet. Contractor shall coordinate closely with the Lime System vendor to provide seamless integration of the Lime System into the plant PLC/SCADA system.

Modular Function: Field Condition Status, QL-650, Liquid Lime System (Panel Power On).

Modular Function: Level, LIT-652, Lime Storage Tank T-652.

Modular Function: Run Status, M-652, Lime Storage Tank Mixer M-652.

Modular Function: Run Command/Stroke Adjust, P-655P (4), Lime Feed Pumps.

In AUTO, provide Flow Pacing as follows:

Start/Stop and adjust stroke of pumps by using Modular Function Flow Pacing.

Control Device: Lime Feed Pump Stroke

Process Flow:

For P-655-1 & -2:

Crosstown: Combined Influent Flow (Existing in SCADA)

South Fayette: Influent Flow FIT-802

For P-655-2, & -4:

Crosstown: Combined Influent Flow (Existing in SCADA)

South Fayette: Combined Filter Effluent (Existing in SCADA)

Dosage Units: mg/l of Lime

AUTOMATIC MODE:

The speed of the selected lime feed pump will be controlled proportional to flow as measured by the flow meters listed above. Use the following equation for speed control:

$$\% \text{ SPEED} = K_i * (\text{FLOW}) * (\text{DOSE})/(\text{STROKE POSITION})$$

K_i = Proportionality constant, function of pump type, scale inhibitor concentration, etc. (to be determined).

Flow = Flow rate in mgd.

DOSE = Desired dose in mg/liter, entered manually.

MANUAL MODE:

- a. In manual mode speed can be manually adjusted from HMI using individual faceplates.

Modular Function: Pressure, PIT-655 (4), Lime Feed Pump Discharge.

Unit Process 68: Sodium Permanganate Storage and Feed

(NOTE: The following loop description is applicable only at the Crosstown facility.

Modular Function: Level, LIT-682-1, Sodium Permanganate Storage Tank T-682-1.

Modular Function: Level, LIT-682-2, Sodium Permanganate Storage Tank T-682-2.

Modular Function: Run Command/Speed Adjust, P-684-X (2), Sodium Permanganate Feed Pumps.

In AUTO, provide Flow Pacing as follows:

Flow Pacing will be based off of flow from 2 sources (Lake McIntosh Pumps and Raw Water Pumps). In AUTO, start the duty feed pump when any of the pumps is on. Pace the feed off of the corresponding flow meter.

Start/Stop and adjust stroke of pumps by using Modular Function Flow Pacing.

Control Device: Sodium Permanganate Feed Pump Speed

Process Flow:

FT-101A (when Lake McIntosh Pumps are running)

FT-902 (when Raw Water Pumps are running)

Dosage Units: mg/l of Sodium Permanganate

MANUAL MODE:

- b. In manual mode speed can be manually adjusted from HMI using individual faceplates.

Modular Function: Field Alarm, FSH-687, Fire Suppression system activated.

Modular Function: Field Alarm, FSH-689, Safety Shower/Eyewash activated.

END OF LOOP DESCRIPTIONS

| PLC INPUT/OUTPUT LISTS | | | | | | | | |
|------------------------|---------|----------------|---|----------|----------|----------|----------|---------|
| PLC | Dwg | Tag No. | Function/Description | DI | DO | AI | AO | Remarks |
| CP-680 | 10-N-02 | CT-LIT-682-1 | LEVEL INDICATION, SODIUM PERMANGANATE STORAGE TANK T-682-1 | | | 1 | | |
| CP-680 | 10-N-02 | CT-LIT-682-2 | LEVEL INDICATION, SODIUM PERMANGANATE STORAGE TANK T-682-2 | | | 1 | | |
| CP-680 | 10-N-02 | CT-P-684-1 ~SF | SPEED FEEDBACK, PRE-SODIUM PERMANGANATE FEED PUMP P-684-1 | | | 1 | | |
| CP-680 | 10-N-02 | CT-P-684-1 ~SK | SPEED COMMAND, PRE-SODIUM PERMANGANATE FEED PUMP P-684-1 | | | | 1 | |
| CP-680 | 10-N-02 | CT-P-684-1 ~IR | IN REMOTE, PRE-SODIUM PERMANGANATE FEED PUMP P-684-1 | 1 | | | | |
| CP-680 | 10-N-02 | CT-P-684-1 ~YS | ON STATUS, PRE-SODIUM PERMANGANATE FEED PUMP P-684-1 | 1 | | | | |
| CP-680 | 10-N-02 | CT-P-684-1 ~FA | FAIL ALARM, PRE-SODIUM PERMANGANATE FEED PUMP P-684-1 | 1 | | | | |
| CP-680 | 10-N-02 | CT-P-684-1 ~RK | RUN COMMAND, PRE-SODIUM PERMANGANATE FEED PUMP P-684-1 | | 1 | | | |
| CP-680 | 10-N-02 | CT-P-684-2 ~SF | SPEED FEEDBACK, PRE-SODIUM PERMANGANATE FEED PUMP P-684-2 | | | 1 | | |
| CP-680 | 10-N-02 | CT-P-684-2 ~SK | SPEED COMMAND, PRE-SODIUM PERMANGANATE FEED PUMP P-684-2 | | | | 1 | |
| CP-680 | 10-N-02 | CT-P-684-2 ~IR | IN REMOTE, PRE-SODIUM PERMANGANATE FEED PUMP P-684-2 | 1 | | | | |
| CP-680 | 10-N-02 | CT-P-684-2 ~YS | ON STATUS, PRE-SODIUM PERMANGANATE FEED PUMP P-684-2 | 1 | | | | |
| CP-680 | 10-N-02 | CT-P-684-2 ~FA | FAIL ALARM, PRE-SODIUM PERMANGANATE FEED PUMP P-684-2 | 1 | | | | |
| CP-680 | 10-N-02 | CT-P-684-2 ~RK | RUN COMMAND, PRE-SODIUM PERMANGANATE FEED PUMP P-684-2 | | 1 | | | |
| CP-680 | 10-N-02 | CT-LSH-688 | HIGH LEVEL, SODIUM PERMANGANATE BUILDING SUMP | 1 | | | | |
| CP-680 | 10-N-02 | CT-FSH-687 | FLOW ALARM, SODIUM PERMANGANATE BUILDING SPRINKLER SYSTEM ACTIVATED | 1 | | | | |
| CP-680 | 10-N-02 | CT-FSH-689 | FLOW ALARM, SODIUM PERMANGANATE BUILDING SAFETY SHOWER ACTIVATED | 1 | | | | |
| | | | | | | | | |
| | | | TOTALS | 9 | 2 | 4 | 2 | |
| | | | | | | | | |

| PLC INPUT/OUTPUT LISTS | | | | | | | | |
|------------------------|---------|-----------|---|----|----|----|----|----------|
| PLC | Dwg | Tag No. | Function/Description | DI | DO | AI | AO | Remarks |
| RTU | 30-N-01 | P-1 ~YS | ON STATUS, RAW WATER PUMP P-1 | 1 | | | | EXISTING |
| RTU | 30-N-01 | P-1 ~RK | RUN COMMAND, RAW WATER PUMP P-1 | | 1 | | | EXISTING |
| RTU | 30-N-01 | P-2 ~YS | ON STATUS, RAW WATER PUMP P-2 | 1 | | | | EXISTING |
| RTU | 30-N-01 | P-2 ~RK | RUN COMMAND, RAW WATER PUMP P-2 | | 1 | | | EXISTING |
| RTU | 30-N-01 | FCV-3 ~OK | OPEN COMMAND, RAW WATER RETURN VALVE FCV-3 | | 1 | | | EXISTING |
| RTU | 30-N-01 | FCV-3 ~CK | CLOSE COMMAND, RAW WATER RETURN VALVE FCV-3 | | 1 | | | NEW |
| RTU | 30-N-01 | FCV-3 ~OS | OPEN STATUS, RAW WATER RETURN VALVE FCV-3 | 1 | | | | EXISTING |
| RTU | 30-N-01 | FCV-3 ~CS | CLOSED STATUS, RAW WATER RETURN VALVE FCV-3 | 1 | | | | EXISTING |
| | | | TOTALS | 4 | 4 | | | |

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 | | | | |
| Record? Y / N | Scale: | | | | | | Modes? P / I / D | | | | |
| Transmit/ Convert? Y / N | Input: | | | | | | SWITCH? Y / N | | | | |
| | Output: | | | | | | Unit Range: | | | | |
| | | | | | | | Differential: fixed/adjustable | | | | |
| | | | | | | | Reset? automatic / manual | | | | |
| ANALOG CALIBRATIONS | | | | | | DISCRETE CALIBRATIONS | | | | Note No. | |
| REQUIRED | | | AS CALIBRATED | | | REQUIRED | | | AS CALIBRATED | | |
| Input | Indicated | Output | Increasing Input | | Decreasing Input | | Number | Trip Point (note rising or falling) | Reset Pt. | | Trip Point (note rising or falling) |
| | | | Indicated | Output | Indicated | Output | | | | | |
| | | | | | | | 1. | | | | |
| | | | | | | | 2. | | | | |
| | | | | | | | 3. | | | | |
| | | | | | | | 4. | | | | |
| | | | | | | | 5. | | | | |
| | | | | | | | 6. | | | | |
| CONTROL MODE SETTINGS: | | | P: | I: | D: | | 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 | | | | | | | | | | | |
| Indicate? Y Record? N | RANGE | VALUE | UNITS | COMPUTING FUNCTIONS? N | | | CONTROL? N | | | | |
| | Chart: | | | Describe: | | | Action? direct / reverse Modes? P / I / D | | | | |
| Transmit/ Convert? Y | Scale: | 1-14 | pH units | | | | SWITCH? N | | | | |
| | Input: | 1-14 | pH units | | | | Unit Range: | | | | |
| | Output: | 4-20 | mA dc | | | | Differential: fixed/adjustable | | | | |
| | | | | | | | Reset? automatic / manual | | | | |
| ANALOG CALIBRATIONS | | | | | | | DISCRETE CALIBRATIONS | | | Note No | |
| REQUIRED | | | AS CALIBRATED | | | | REQUIRED | | | | AS CALIBRATED |
| Input | Indicated | Output | Increasing Input | | Decreasing Input | | Number | Trip Point | Reset Pt. | Trip Point | Reset Pt. |
| | | | 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. | | | | |
| 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
EXAMPLE

Rev.06.05.92

| | | | | | |
|--|--|------------------|------------------------------------|--------------------------------|------------------|
| PARTS | Project Name: <i>SFO SEWPCP</i> | | Project Number: <i>SFO10145.G2</i> | | |
| Body | Type: <i>Vee-Ball</i> | | Mfr: <i>Fisher Controls</i> | | |
| | Size: <i>4-inch</i> | | Model: <i>1049763-2</i> | | |
| | Line Connection: <i>159 # ANSI Flanges</i> | | Serial #: <i>1003220</i> | | |
| Operator | Type: <i>Pneumatic Diaphragm</i> | | Mfr: <i>Fisher Controls</i> | | |
| | Action: <i>Linear - Modulated</i> | | Model: <i>4060D</i> | | |
| | Travel: <i>3-inch</i> | | Serial #: <i>2007330</i> | | |
| Positioner | Input Signal: <i>3-15 psi</i> | | Mfr: <i>Fisher Controls</i> | | |
| | Action: <i>Direct - air to open</i> | | Model: <i>20472T</i> | | |
| | Cam: <i>Equal percentage</i> | | Serial #: <i>102010</i> | | |
| Pilot Solenoid | Action: | | Mfr: | | |
| | Rating: <i>None</i> | | Model: | | |
| | | | Serial #: | | |
| I/P Converter | Input: <i>4-20 mA dc</i> | | Mfr: <i>Taylor</i> | | |
| | Output: <i>3-15 psi</i> | | Model: <i>10-T-576-3</i> | | |
| | Action: <i>Direct</i> | | Serial #: <i>1057-330</i> | | |
| Position Switch | Settings: <i>Closed / Open 5 deg, rising</i> | | Mfr: <i>National Switch</i> | | |
| | Contacts: <i>Close / Close</i> | | Model: <i>1049-67-3</i> | | |
| | | | Serial #: <i>156 & 157</i> | | |
| Power Supply | Type: <i>Pneumatic</i> | | Air Set Mfr: <i>Air Products</i> | | |
| | Potential: <i>40 psi</i> | | Model: <i>3210D</i> | | |
| | | | Serial #: <i>1107063</i> | | |
| ADJUSTMENTS | Initial | Date | VERIFICATION | Initial | Date |
| Air Set | <i>JDS</i> | <i>Jun-06-92</i> | Valve Action | <i>JDS</i> | <i>Jun-03-92</i> |
| Positioner | <i>JDS</i> | <i>Jun-06-92</i> | Installation | <i>JDS</i> | <i>Jun-03-92</i> |
| Position Switches | <i>JDS</i> | <i>Jun-06-92</i> | Wire Connection | <i>JDS</i> | <i>Jun-04-92</i> |
| I/P Converter | <i>JDS</i> | <i>Jun-07-92</i> | Tube Connection | <i>JDS</i> | <i>Jun-04-92</i> |
| Actual Speed | <i>JDS</i> | <i>Jun-07-92</i> | | | |
| REMARKS: <i>Valve was initially installed backwards.</i> <i>Observed to be correctly installed May-25-92</i> | | | | Valve Ready for Startup | |
| | | | | By: <i>J.D. Sewell</i> | |
| | | | | Date: <i>Jun-07-92</i> | |
| | | | | Tag No.: <i>FCV-10-2-1</i> | |

[illegible]

CH2M HILL PERFORMANCE ACCEPTANCE TEST SHEET
EXAMPLE

Rev.06.05.92

| | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|--|-------------------|---------------------------------|-------------------------------|-------------|---|---|----|----|-------------|---|-------|-------|-------|------------------|---|------|-----|-----|-------------------|---|------|-----|-----|-------------------|---|------|-------|-------|
| Project Name: <i>SFO SEWPCP Plant Expansion</i> | | Project No.: <i>SFO12345.C1</i> | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Demonstration Test(s): For each functional requirement of the loop: (a) List and number the requirement. (b) Briefly describe the demonstration test. (c) Cite the results that will verify the required performance. (d) Provide space for signoff. | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 1. MEASURE EFFLUENT FLOW | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 1.a With no flow, water level over weir should be zero and | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| FIT indicator should read zero. | | | Jun-20-92 BDG | | | | | | | | | | | | | | | | | | | | | | | | | |
| 2. FLOW INDICATION AND TRANSMISSION TO LP & CCS | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| With flow, water level and FIT indicator should be related by expression | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| $Q(\text{MGD}) = 429 * H^{2/3}$ (H = height in inches of water over weir). | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Vary H and observe that following. | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 2.a Reading of FIT indicator. | | | Jun-6-92 BDG | | | | | | | | | | | | | | | | | | | | | | | | | |
| 2.b Reading is transmitted to FI on LP-521-1. | | | Jun-6-92 BDG | | | | | | | | | | | | | | | | | | | | | | | | | |
| 2.c Reading is transmitted and displayed to CCS. | | | Jun-6-92 BDG | | | | | | | | | | | | | | | | | | | | | | | | | |
| <table style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 20%;">H(measured)</td> <td style="width: 10%;">0</td> <td style="width: 10%;">5</td> <td style="width: 10%;">10</td> <td style="width: 10%;">15</td> </tr> <tr> <td>Q(computed)</td> <td>0</td> <td>47.96</td> <td>135.7</td> <td>251.7</td> </tr> <tr> <td>Q(FIT indicator)</td> <td>0</td> <td>48.1</td> <td>137</td> <td>253</td> </tr> <tr> <td>Q(LI on LP-521-1)</td> <td>0</td> <td>48.2</td> <td>138</td> <td>254</td> </tr> <tr> <td>Q(display by CCS)</td> <td>0</td> <td>48.1</td> <td>136.2</td> <td>252.4</td> </tr> </table> | | | | H(measured) | 0 | 5 | 10 | 15 | Q(computed) | 0 | 47.96 | 135.7 | 251.7 | Q(FIT indicator) | 0 | 48.1 | 137 | 253 | Q(LI on LP-521-1) | 0 | 48.2 | 138 | 254 | Q(display by CCS) | 0 | 48.1 | 136.2 | 252.4 |
| H(measured) | 0 | 5 | 10 | 15 | | | | | | | | | | | | | | | | | | | | | | | | |
| Q(computed) | 0 | 47.96 | 135.7 | 251.7 | | | | | | | | | | | | | | | | | | | | | | | | |
| Q(FIT indicator) | 0 | 48.1 | 137 | 253 | | | | | | | | | | | | | | | | | | | | | | | | |
| Q(LI on LP-521-1) | 0 | 48.2 | 138 | 254 | | | | | | | | | | | | | | | | | | | | | | | | |
| Q(display by CCS) | 0 | 48.1 | 136.2 | 252.4 | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
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| | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 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

Sheet 1 of 2

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.

| Fiber ID | Use/Spare | Measured Attenuation (dB) | | | |
|----------|-----------|------------------------------|----------|-------------|----------|
| | | Hub-to-Node | | Node-to-Hub | |
| | | 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 |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
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| | | | | | |

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 00, Instrumentation and Control for Process Systems.

2.02 SIGNAL CHARACTERISTICS

- A. As defined in Section 40 90 00, 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-Iddec; Standard Cam Switch.
 - 2) Electros witch; 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 43 40 01
POLYETHYLENE STORAGE TANK

PART 1 GENERAL

1.01 WORK INCLUDED

- A. This section covers the Work necessary to furnish and install bulk chemical storage tanks for sodium permanganate.

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 bulk chemical storage tanks, including wall thickness and methods and locations of support and anchorage.
- 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, 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. IMFO Pad and Anchor Bolt Drawings: Drawings shall be provided that show all data and details required for design of the tank anchoring points by the building supplier. Include locations and dimensions of required anchors.
 - 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 IBC Calculations for anchor bolt type, size, and location shall be indicated for the controlling load condition.
 - 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 polyethylene 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 chemicals.
- C. Like items of materials and equipment shall be the end products of one manufacturer in order to provide standardization for appearance operation, maintenance spare parts, and manufacturer's service.

2.02 MANUFACTURERS

- A. Poly Processing Company.
- B. Or Engineer-approved equal.

2.03 SERVICE CONDITIONS

- A. Location: Indoors.
- B. Ambient Air Temperature Range: 50 to 100 degrees F.
- C. Relative Humidity: Up to 100 percent.
- D. Operating Pressure: Atmospheric.
- E. Stored Materials:

| Stored Materials | | |
|---------------------|------------|------------------|
| Equipment | Chemical | Specific Gravity |
| Sodium Permanganate | 20% NaMNO4 | 1.16 |

2.04 TANK DESIGN CRITERIA

- A. Seismic Load: See the Structural General notes in the Drawings.
- 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 (XLHDPE) 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* |
| Sodium Permanganate Tanks (T-682-1, T-682-22-1) | 500 gal | 4'-0" | 6'-4" |
| *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 |
| Polyethylnene 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. Contractor to coordinate anchor locations with building system manufacturer.
- 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.

2.07 FITTINGS

- A. Tank fittings and openings shall be provided as shown on the Tank Data Sheet.
- B. Coordinate tank fill nozzle requirements with chemical supplier.
- C. 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.
- D. Provide overflow pipe connecting the tank overflow with drain as shown on Tank Data Sheet. Overflow pipe shall be supported externally by pipe supports.
- E. Fittings shall be PVC 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.
- F. All flanged fittings shall be gasketed with materials compatible with the chemical service.
- G. Bolted fittings shall use Hastelloy C bolts with polyethylene-encapsulated heads and PVC external flanges.
- H. All materials used in tank fitting assemblies shall be resistant to the stored chemicals. No wetted fittings or appurtenances shall be of metallic construction.
- I. Provide flexible connector, Integrally Molded Flanged Outlet (IMFO) where indicated on data sheets.

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 internal 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 5 feet on center.
3. Pipe supports shall allow removal of supported pipes.
4. Complete with Hastelloy C bolts, nuts, washers, and other necessary hardware for easy field assembly.

E. Tank Pad: Provide manufacturer's standard tank pad for IMFO fittings to elevate tank bottom from the building floor and provide clearance for IMFO fittings.

F. 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.

G. Anchor Bolts: Type 316, stainless steel bolts, sized by fabricator and at least 3/4-inch diameter, or as shown and as specified in Section 05 50 00, Metal Fabrications.

2.09 SOURCE QUALITY CONTROL

A. General: The tank fabricators shall have a quality control procedure adequate to ensure that all fabrication complies with these Specifications.

B. Factory Tests:

1. Impact Tests: A representative sample from each tank shall undergo a factory impact test. Impact test must meet the requirements of ASTM D1998.
2. Gel Tests: A representative sample from each tank provided shall undergo a factory gel test, as prescribed by ASTM D1998.
3. Hydrostatic Leak Tests:
 - a. Perform on each tank.
 - b. Fill to overflow nozzle; allow to stand for 24 hours with no visible leakage.

4. Wall Thickness: Each tank shall have an actual wall thickness measurement taken at every 90 degrees, at each one foot elevation, up to three feet from the bottom of the tank.
5. Reports: Certify, by signature, the results of the factory testing.

PART 3 EXECUTION

3.01 INSTALLATION

- A. In accordance with the manufacturer's written instructions.
- B. Contractor shall provide all supervision, labor, tools, construction equipment, incidental materials, and the necessary services required to complete the installation and testing of the equipment.
- C. Accurately place anchor bolts using templates furnished by the manufacturer or as otherwise recommended by manufacturer and as specified in Section 05 50 00, Metal Fabrications.
- D. Tanks shall be installed in such a manner that no stresses shall be applied to flanged outlet as per manufacturer's installation instructions.
- E. Uniform and level surface contact shall be made between all tank bottoms and the support foundations by means of grouting. Tanks shall be set in wet grout tapered from a point 1-inch higher at tank center to the foundation edges. Initially, grouting shall be finished to leave no voids. Tanks shall be settled down squeezing out excess grout in such a manner as to leave no voids in the tank bottom/foundation interface. The grout shall not be used to support any load, only to fill irregularities in the tank bottoms and foundations. The in-place tanks shall not be exposed to any loads until the grout has hardened.
- F. Bolt torques on gaskets shall be as recommended by the equipment manufacturer.

3.02 FIELD QUALITY CONTROL

- A. Functional 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 tanks filled with 20 percent sodium permanganate 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 T-682-1
2. Supplement 2, Tank Data Sheet T-682-2

END OF SECTION

TANK NAME: SODIUM PERMANGANATE STORAGE TANK 1

TAG NUMBER(S): T-682-1

QUANTITY: 1

SERVICE: SODIUM PERMANGANATE (20%)

SPECIFIC GRAVITY: 1.16

pH RANGE: 6-8

TEMP. RANGE (°F): MIN: 10° F MAX 110° F

DIAMETER: 4 FEET - 0 INCHES

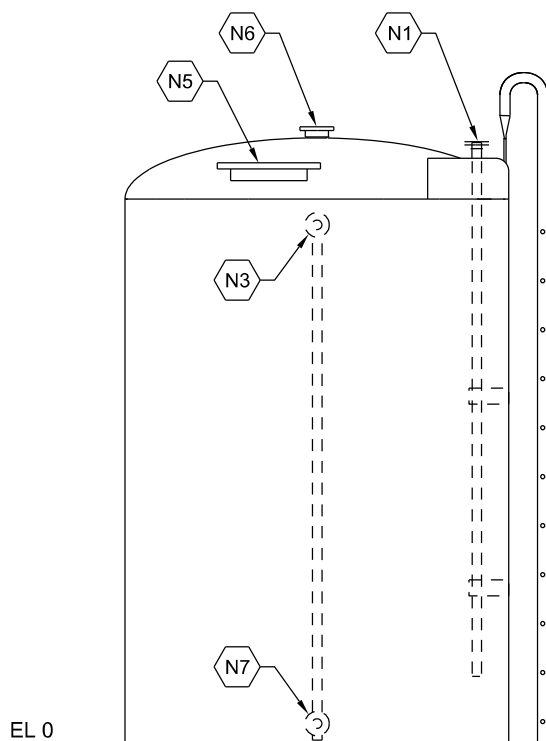
STRAIGHT SHELL HEIGHT: 6 FEET - 4 INCHES (NOTE 1)

CAPACITY: 500 GALLONS

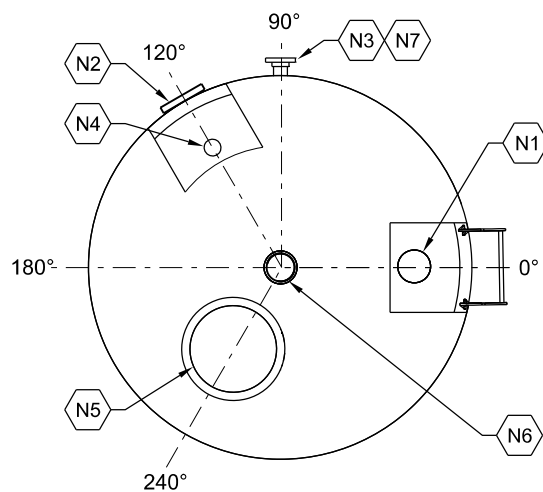
STRAIGHT SKIRT HEIGHT: N/A

NOTES:

1. IMFO PAD TO BE INCLUDED. TOTAL SHELL HEIGHT WITH IMFO PAD IS 6 FEET - 8 INCHES.
2. HORIZONTAL NOZZLE ELEVATIONS TO CENTERLINE OF FITTING.
3. SEE SPECIFICATIONS FOR ADDITIONAL INFORMATION.
4. EXTEND FILL LINE (N1) 12" FROM TANK BOTTOM.
5. OUTLET (N2) AND DRAIN (N7) SHALL BE LOCATED AT INVERT OF TANK BOTTOM.
6. NOZZLES SHALL EXTEND 6" FROM TANK UNLESS OTHERWISE NOTED
7. VENDOR TO PROVIDE INTERIOR FILLING LINE AS PART OF TANK.

COMPOSITE SECTION

NTS

PLAN

NTS

| NOZZLES | MARK | QTY | SIZE | CL ELEV | CL RADIUS | NOTES | DESIGN DATA |
|------------------|------|-----|------|---------|-----------|------------|--|
| FILL | N1 | 1 | 2" | TOP | 1'-0" | | TANK LOCATION: INDOORS |
| OUTLET | N2 | 1 | 1" | 0'-1" | NA | IMFO | WIND LOADS: NO SNOW LOADS: NO |
| OVERFLOW | N3 | 1 | 3" | 6'-1" | NA | | TYPE OF TOP HEAD: DISH |
| LEVEL INSTRUMENT | N4 | 1 | 8" | TOP | 1'-0" | ULTRASONIC | TYPE OF BOTTOM HEAD: FLAT |
| ACCESSWAY | N5 | 1 | 12" | TOP | 1'-0" | | LADDER REQUIRED: YES |
| VENT | N6 | 1 | 3" | TOP | 1'-0" | | PIPE SUPPORTS FOR INTERIOR PIPING: YES |
| DRAIN | N7 | 1 | 3" | 0'-1" | NA | IMFO | PIPE SUPPORTS FOR EXTERIOR PIPING: YES |
| | | | | | | | GRADUATED STANDPIPE: NO |
| | | | | | | | HEAT TRACING: NO |
| | | | | | | | INSULATION: NO |
| | | | | | | | HANDRAILS: NO |
| | | | | | | | TIE DOWN SYSTEM: YES |
| | | | | | | | LATERAL RESTRAINT: YES |
| | | | | | | | N/A = NOT APPLICABLE |

TANK NAME: SODIUM PERMANGANATE STORAGE TANK 2

TAG NUMBER(S): T-682-2

QUANTITY: 1

SERVICE: SODIUM PERMANGANATE (20%)

SPECIFIC GRAVITY: 1.16

pH RANGE: 6-8

TEMP. RANGE (°F): MIN: 10° F MAX 110° F

DIAMETER: 4 FEET - 0 INCHES

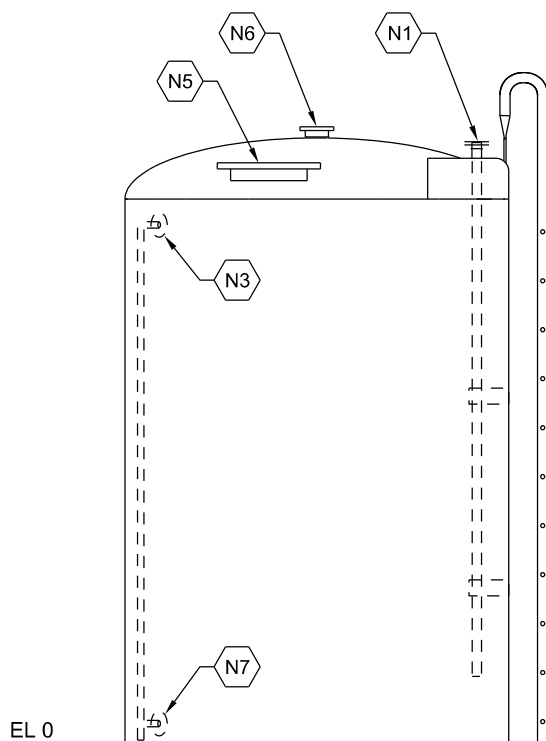
STRAIGHT SHELL HEIGHT: 6 FEET - 4 INCHES (NOTE 1)

CAPACITY: 500 GALLONS

STRAIGHT SKIRT HEIGHT: N/A

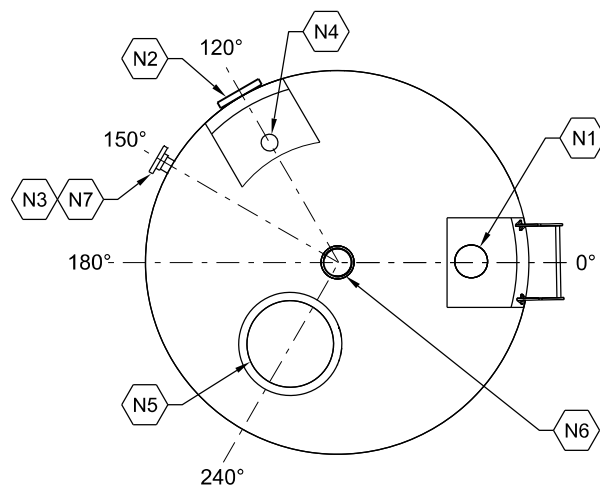
NOTES:

1. IMFO PAD TO BE INCLUDED. TOTAL SHELL HEIGHT WITH IMFO PAD IS 6 FEET - 8 INCHES.
2. HORIZONTAL NOZZLE ELEVATIONS TO CENTERLINE OF FITTING.
3. SEE SPECIFICATIONS FOR ADDITIONAL INFORMATION.
4. EXTEND FILL LINE (N1) 12" FROM TANK BOTTOM.
5. OUTLET (N2) AND DRAIN (N7) SHALL BE LOCATED AT INVERT OF TANK BOTTOM.
6. NOZZLES SHALL EXTEND 6" FROM TANK UNLESS OTHERWISE NOTED
7. VENDOR TO PROVIDE INTERIOR FILLING LINE AS PART OF TANK.



COMPOSITE SECTION

NTS



PLAN

NTS



| NOZZLES | MARK | QTY | SIZE | CL ELEV | CL RADIUS | NOTES | DESIGN DATA |
|------------------|------|-----|------|---------|-----------|------------|--|
| FILL | N1 | 1 | 2" | TOP | 1'-0" | | TANK LOCATION: INDOORS |
| OUTLET | N2 | 1 | 1" | 0'-1" | NA | IMFO | WIND LOADS: NO SNOW LOADS: NO |
| OVERFLOW | N3 | 1 | 3" | 6'-1" | NA | | TYPE OF TOP HEAD: DISH |
| LEVEL INSTRUMENT | N4 | 1 | 8" | TOP | 1'-0" | ULTRASONIC | TYPE OF BOTTOM HEAD: FLAT |
| ACCESSWAY | N5 | 1 | 12" | TOP | 1'-0" | | LADDER REQUIRED: YES |
| VENT | N6 | 1 | 3" | TOP | 1'-0" | | PIPE SUPPORTS FOR INTERIOR PIPING: YES |
| DRAIN | N7 | 1 | 3" | 0'-1" | NA | IMFO | PIPE SUPPORTS FOR EXTERIOR PIPING: YES |
| | | | | | | | GRADUATED STANDPIPE: NO |
| | | | | | | | HEAT TRACING: NO |
| | | | | | | | INSULATION: NO |
| | | | | | | | HANDRAILS: NO |
| | | | | | | | TIE DOWN SYSTEM: YES |
| | | | | | | | LATERAL RESTRAINT: YES |
| | | | | | | | N/A = NOT APPLICABLE |

**SECTION 43 40 10
LIME SLURRY CHEMICAL
STORAGE AND FEED SYSTEM**

PART 1 GENERAL

1.01 SCOPE AND RESPONSIBILITIES

- A. Owner has preselected and prenegotiated scope and price for certain Work specified herein with the Supplier, Burnett Lime Co., Inc.
- B. The prenegotiated scope includes, but is not limited to, manufacturing and furnishing equipment and materials, delivering to the jobsite, providing various documentation, installing, and providing services, as specified herein. The Contractor shall coordinate with the Supplier regarding details of Supplier's scope.
- C. Additional documentation concerning Supplier's prenegotiated scope and price is included as supplement to this Specification.
- D. The Supplier shall furnish all labor, materials, equipment, interconnecting piping, and interconnecting electrical and controls appurtenances required to furnish and install two complete bulk slurry storage and feed systems as specified herein and as shown as on the Drawings. The Lime Feed System shall be ANSI/NSF 61 Certified. One system shall be installed at the Crosstown Water Treatment Plant and the second system shall be installed at the South Fayette Water Treatment Plant.
- E. The Contractor's responsibilities shall include, but are not limited to, procurement, unloading/receipt at the jobsites, storage, handling, coordination, testing, and startup.
- F. 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. All electrical, mechanical, metal, painting, and instrumentation work included herein shall conform to the applicable sections or divisions of this Project except as otherwise shown or specified.

- B. The Drawings show the approximate location of the storage tanks, feed buildings, and interconnecting pipe and electrical locations. Not all items incidental to the lime solution system are shown or specified. It is the intent of these Specifications that the Contractor is to provide a complete and workable system whether or not any specific component is shown or specified.
- C. Coordination: The Contractor and equipment supplier shall review the installation requirements for the facility and coordinate with the requirements under other applicable sections and divisions of the Specifications.

1.03 QUALITY ASSURANCE

- A. Single Source: For coordination purposes, all materials, equipment, and incidentals, whether or not shown or specified herein, shall be supplied to the Contractor by the lime slurry system supplier unless otherwise indicated.
- B. Source Quality Control:
 - 1. Each tank shall be given a hydrostatic test by the tank manufacturer before shipment by filling the tank with water to the overflow pipe invert elevation. The hydrostatic test shall continue for a minimum of 24 hours and test results certified to the Engineer.
 - 2. Each tank shall be inspected for defects, holidays, or other potential sources of corrosion in accordance with requirements of ASTM D2563 and as inspected herein.
 - 3. All welding and welding procedures shall be qualified to AWS D1.1.
 - 4. Each tank shall be visually inspected to determine that the finished tank wall shall be free, as commercially practicable, of visual defects such as foreign inclusions, air bubbles, pinholes, pimples, excessive welding that will impair the serviceability of the vessel.

1.04 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 the handling of dangerous chemicals.
 - 2. Instrument Society of America, ISA.
 - 3. Joint Industrial Council, JIC.
 - 4. National Electric Manufacturer's Association, NEMA.
 - 5. National Electrical Code, NEC.
 - 6. Institute of Electrical and Electronic Engineer's, IEEE.
 - 7. American Welding Society.
 - 8. American National Standards Institute, ANSI.
 - 9. Anti-Friction Bearing Manufacturers Association (AFBMA)
 - 10. Standards of American Water Works Association (AWWA).

- B. Each lime storage and feed system shall be preassembled and shop tested to ensure compliance with pressure and operational requirements.

1.05 SUBMITTALS

- A. Shop Drawing: Submit for approval the following:

1. Manufacturer/Supplier's literature, illustrations, Specifications and bill of materials for each component of the system. Data shall include a complete description in sufficient detail to permit comparison with the technical specifications.
2. Calculations and Drawings stamped by an Engineer registered in the State of Georgia on structural tank design, minimum steel thickness, tank anchorage, equipment shelter design and anchorage, feed pump and other equipment anchorage, and compliance with the design criteria shown on the Structural General Notes in the Drawings and Section 01 88 15, Anchorage and Bracing. Include calculations for hydrostatic and other operational loads.
3. Component Manufacturer's Seismic Certificate of Compliance in accordance with Section 01 45 33, Special Inspection, Observation, and Testing.
4. Dimensions (including anchor bolt layout), materials, size, weight, and performance data.
5. Drawings showing fabrication, assembly, installation and wiring diagrams. Wiring diagrams shall consist of, at a minimum, control schematics, including coordination with other electrical control devices operating in conjunction with the lime slurry feed system.
6. Motor Data: For each motor furnished, a certified motor data sheet for the actual motor or for a previously manufactured electrically duplicate motor which was tested.
7. Pump Data: For each pump furnish a performance certification indicating: head, capacity, efficiency and horsepower.
8. A list of any and all parameters, ratings or other characteristics where the proposed lime slurry feed system deviates from the requirements set forth in these Specifications.
9. Affidavits of compliance with referenced standards and codes.
10. Components supplied to make unit suitable for outdoor service.
11. Functional description of instrumentation and control to be supplied including list of parameters monitored, controlled or alarmed.
12. Control panel elevation drawings showing construction and placement of operator interface devices and other elements.
13. Control panel bill of materials.
14. Power and control wiring diagrams, including terminals and numbers.
15. Instrument cut sheets and bill of materials.
16. Manufacturer shall provide a detailed conduit layout for all equipment provided within the Specification.

- B. Operation and Maintenance Data: For each water treatment plant, submit two copies of complete Operation and Maintenance Manuals as described below:
1. Required Operation Data:
 - a. Complete, detailed operating instructions for each piece of equipment.
 - b. Explanations for all safety considerations relating to operations.
 - c. Recommended spare parts lists.
 2. Required Maintenance Data:
 - a. Maintenance data shall include all information and instructions required by plant personnel to keep equipment properly cleaned, lubricated and adjusted so that it functions economically throughout its full design life.
 - b. Explanation with illustrations as necessary for each maintenance task.
 - c. Recommended schedule of maintenance tasks.
 - d. Lubrication charts and tables of alternate lubricants.
 - e. Troubleshooting instructions.
 - f. List of maintenance tools and equipment.
 - g. Name, address and phone number of manufacturer and manufacturer's local service representative.

1.06 GUARANTEE AND WARRANTY

- A. Prior to acceptance of the lime slurry feed system, provide written warranty from the system manufacturer that includes the following statements:
1. System manufacturer has inspected the installation during and after completion and the lime slurry feed system is free from faults and defects and is in conformance with the Contract Documents.
 2. The lime slurry feed system will remain free of defects for a period of 1 year from the date of final acceptance.
 3. If the equipment requires repair or replacement as a result of ordinary wear and tear under normal conditions, the system manufacturer will repair or replace such equipment as required without cost to the Owner.

1.07 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 MANUFACTURERS

- A. CAL-FLO Slurry System, Burnett Lime Company.

2.02 SYSTEM DESCRIPTION

- A. Each bulk lime slurry delivery system shall consist of a complete and independent system for receiving and storing calcium hydroxide and feeding the slurry to two injection points. The bulk slurry chemical system shall consist of one baffled bulk lime slurry delivery storage tank. The tank shall have a top entry mixer, feed pumps, ultrasonic level indicator, fill pipe, vent pipe, overflow pipe, recirculation pipe, enclosure over feed pumps, control panels for the feed pumps, and a vent fan, heater, and insulation for the enclosure. The bulk slurry chemical system shall be factory pre-assembled to the maximum practical extent. Factory assembly shall include enclosure assembly prewiring and piping.
- B. The bulk slurry chemical system shall be designed for easy, safe, and reliable performance. The bulk tank shall be designed for receiving 30 percent lime. The lime feed equipment shall be capable of feeding calcium hydroxide at a 15 percent to 25 percent solution to the two injection point locations indicated on the Drawings with the feed rates listed below. Each feed range shall be covered using two pumps:
 - 1. Crosstown Water Treatment Plant:
 - a. Post-Lime (Combined Filtered Effluent) Injection Point: 0.65 to 25.23 gph at 15 percent solution.
 - b. Pre-Lime (Raw Water) Injection Point: 0.65 to 25.23 gph at 15 percent solution.
 - c. For both the pre-lime and post-lime injection flows, the maximum dose rate is based on the plant's permitted flow capacity of 13.5 mgd and a lime dose of 10 mg/L as CaCO₃ at 15 percent slurry solution.
 - 2. South Fayette Water Treatment Plant:
 - a. Post-Lime (Finished Water) Injection Point: 2.24 to 19.53 gph at 15 percent solution.
 - b. Pre-Lime (Raw Water) Injection Point: 2.80 to 19.53 gph at 15 percent solution.

- c. For both the pre-lime and post-lime injection flows, the maximum dose rate is based on the plant's permitted flow capacity of 9.5 mgd and a lime dose of 11 mg/L as CaCO_3 at 15 percent slurry solution.
- C. The calcium hydroxide slurry shall be a stabilized 30 percent aqueous suspension with a specific gravity between 1.19 g/ml and 1.23 g/ml.
 - 1. 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.
- D. The manufacturer shall be responsible for providing any additional materials above the lime system slab to connect to the lime slurry feed pipes, drains, water supply pipes, and electrical and control connections shown on the Drawings. The system manufacturer is also required to provide and install the lime slurry tubing from the storage area to the injection points and two injection quills at the injection taps (total of four injection quills to be provided at each water treatment plant). The Contractor shall install the taps and carrier pipe to the two injection locations (pre-lime and post-lime) from the storage tank at each water treatment plant. Each injection location has three liquid lime tubes and two injection points: one serving as a duty and the other as a backup. Feed tubes shall be supplied with quick connects. One tube shall be connected to each injector; the third tube to each injection location shall be left loose, but with enough slack to connect to either injection quill.

2.03 STORAGE TANK AND EQUIPMENT ENCLOSURE

- A. Each lime slurry system shall include one 16,000-gallon capacity storage tank. Each tank shall be carbon steel flat bottom, dome top, vertical storage tank with a diameter of 12 feet. The tank shall have an internal baffle system, and the tank top shall be designed to support all top mounted equipment, including a top entry mixer mount.
- B. All specified nozzles and openings for pipe connections, monitoring equipment, and other appurtenances shall be provided. All fittings for the pipe connections shall also be provided. Tank shall be provided with a ladder to the top of the tank and the top shall be equipped with a full tank perimeter handrail.

- C. The tank shall be fabricated of carbon steel having the following minimum thicknesses: 1/4-inch top, 3/16-inch wall, 1/4-inch bottom. A minimum of six anchor bolt flanges and two lift lugs shall be provided for the tank. Stainless steel anchor bolts shall be appropriately sized in accordance with Section 01 88 15, Anchorage and Bracing, and provided and installed for each tank by the equipment vendor. Pipe supports shall be mounted from the tank as required to provide proper support to piping running to the top of the tank.
- D. The enclosures over the feed pumps shall be a prefabricated metal building furnished with a door assembly consisting of one 36-inch by 78-inch access door with hardware. Minimum clear height inside the enclosure shall be 7 feet. The enclosure building shall be stainless steel frame, (1.25-inch stainless steel tube) with 3-inch vinyl backed insulation. Exterior wall panels, roof panels, and flashings shall be 26-gauge and shall be coated with a factory finish of Valspar Corporation Polar White PMW1614 over Valspar Corporation Dynaprime PMY0154 primer. Primer coat shall be a minimum 0.2 mil dry film thickness; finish coat shall be a minimum 0.8 mil dry film thickness. The enclosure shall include the following accessories:
 - 1. One 1,500-watt UL-listed heater with thermostat/on-off switch as manufactured by Dayton, Model 5ZK52D, or equal.
 - 2. One fan having a minimum free air capacity of 520 cfm. The fan shall be thermostatically controlled. Fan shall be fitted with a wire guard and a removable interior vent door. Provide a manually adjustable air intake vent with FRP screen.
 - 3. Interior lighting shall be by one 4-foot long, two-lamp surface-mounted fluorescent fixture controlled by a weatherproof interior switch.
 - 4. Provide one 120-volt interior GFI type electrical outlet with gasketed, spring-loaded cover.
 - 5. All lighting, heater, ventilation, switches and outlets shall be pre-wired using three-wire, color-coded, No. 12 THHN, copper wire in Schedule 80 PVC conduit.
- E. The enclosure assembly shall fit flush to the tank as to minimize water and moisture from entering the enclosure.
- F. Lime system tank and pump enclosure shall be provided with grounding lugs.
- G. Tank appurtenances shall be as follows:
 - 1. 12-inch mixer mounting nozzle (top).
 - 2. 24-inch atmospheric manhole/inspection port (top).
 - 3. 24-inch manhole (3-1/2 feet above bottom).
 - 4. 6-inch nozzle (pump suction, 9 inches above bottom).
 - 5. 6-inch nozzle (pump suction, 9 inches above bottom).
 - 6. 6-inch nozzle (pump suction, 9 inches above bottom).

7. 6-inch nozzle (pump suction, 9 inches above bottom).
8. 3-inch nozzle (drain, 2 inches above bottom).
9. 4-inch nozzle (overflow, 6 inches below top).
10. 2-inch nozzle (spare, top).
11. 6-inch nozzle (level sensor – 18 inches off wall, top).
12. 2-inch nozzle (water fill, top).
13. 2-inch nozzle (slurry fill, top).
14. 3-inch nozzle (re-circulation).
15. Four 10-inch wide by 18 feet long gusseted baffles fabricated from 1/4-inch plate positioned 1 inch off the wall.
16. Anchor lugs (6).
17. Ladder, ladder cage and full tank perimeter handrail shall be of cold rolled steel.
18. Standoff pipe supports and clamps (maximum 8 feet on center for overflow, slurry and water lines).
19. Lift lugs (2).
20. Fill pipe (2 inches), overflow pipe (4 inches), with quick-connects.
21. Four 3/4-inch by 16-inch stainless anchors furnished and installed by Burnett Lime Company.

2.04 BULK TANK MIXER

- A. A motorized tank agitator/mixer shall be mounted onto the top of the tank for the purpose of maintaining an even suspension from top to bottom of the tank. The mixer shall run continuously with alarm contacts provided if the mixer should stop running.
- B. Tank mixer shall also have the following features:
 1. Mixer gear box reducer for speed control, carbon steel shaft, and stainless steel mounting hardware.
 2. Mixer motor, 7.5 hp, 240/480 volts 60-Hz, three-phase.
 3. Mixer shaft suspended from gear box.
 4. Three mixer blade sets to be used for the appropriate specific slurry concentration.

2.05 FILL PIPE

- A. The lime slurry fill pipe shall be 2-inch diameter, Schedule 80 PVC complete with all fittings and truck hose quick connect with dust cap. The fill pipe shall be supported to the tank and shall be installed at the jobsite. The fill pipe shall be located on the tank pad to allow filling from a tanker truck. Note that for the South Fayette WTP, a total hose length of 40 to 50 feet will be required to reach from the tanker truck to the tank's fill connection point.
- B. The fill pipe shall enter the tank on the top near the side.

- C. The level indicator for the lime slurry bulk tank shall be located adjacent to fill pipe for the tank.

2.06 LIME FEED PUMPS

- A. The lime feed pumps shall be suitable for pumping 15 percent to 25 percent lime slurry to the points as shown on the Drawings. The metering pumps shall be positive displacement, reciprocating pumps with tubular diaphragms. The metering pump mechanism must contain a straight through flow path hydrotube made of elastomer material suitable for lime service. Two pumps (operated in a Lead/Lag arrangement) shall be provided for each injection point at each water treatment (total of four pumps per water treatment plant). Lime slurry feed rates shall be as described hereinbefore.
- B. The pumps shall be capable of receiving a 4 mA to 20 mA control signal. The pumps shall be capable of manual operation or may be remotely operated from a plant SCADA System via Ethernet cable provided by the General Contractor to the Lime System Allen Bradley 1761 NET-ENI Ethernet module. The metering pumps shall have a metering accuracy of plus or minus 1 percent based on a 10:1 flow range. The metering pump shall be Pulsafeeder, Model 7120 series to meet the required feed ranges.

2.07 CHEMICAL FEED LINES

- A. The slurry feed lines shall be accessible in a PVC conduit (conduit provided by the General Contractor).
- B. The feed tubing to the feed points shall be clear flexible reinforced PVC hose and shall be equal to Kuri Tec Series No. K3150. Tubing diameter shall be as determined by the supplier.

2.08 VALVES AND APPURTENANCES

- A. Water isolation valves and flush valves shall be true union PVC ball valves.
- B. One 3/4-inch hose bib shall be provided on water supply header.
- C. Isolation valves for liquid lime service shall be 2-inch flanged, pinch valves, ONYX Controls or equal. There shall be two limit switches on all pinch valves. One limit switch shall be interlocked in the pump run circuit to ensure positive position of the valve for pump protection. The second limit switch shall provide a water flush on system shutdown.
- D. Water meter shall be 2-inch, Badger positive displacement AWWA approved water meter with 1-1/4 to 170 gpm range indicator.

2.09 SHUTDOWN FLUSH SYSTEM

- A. The lime slurry chemical system shall be furnished with an automatic flush system connected to the water supply and the flush valve must be opened to flush the pump and slurry line.

2.10 CONTROL

- A. General: See Section 40 99 00, Package Control Systems, for general instrumentation and control requirements. Instrumentation, control, and electrical components provided under this section shall comply with requirements of Section 40 99 00, Package Control Systems.
- B. Controls:
 - 1. Provide LCP-650 and FP-652 at each water treatment plant. Panels shall be NEMA 4X, stainless steel. Panels shall be bottom entry with flange-mounted disconnect.
 - 2. LCP-650: All motor starters, relays, timers, surge suppressors, and devices for the control and operation of the equipment shall be housed in a control panel. The control panel shall also house the Lime System PLC Micrologix 1500 with NET ENI card (Ethernet cable and conduit by General Contractor). Local manual operation shall be available at the Lime Control Panel LCP-650.
 - 3. FP-652: Lime level control panel shall house the Milltronics MultiRanger level transmitter and tank level indicator. The level indicator shall produce a high level alarm and a re-order alarm light. Additional contact shall be available for remote monitoring.
 - 4. Provide a local disconnect switch for each pump system, and a main disconnect switch for the entire lime storage and feed system.
 - 5. Operator Controls and Indications:
 - a. The feed pumps shall not start unless the corresponding pinch valve from the slurry tank is opened.
 - b. Start pump at desired feed rate. Status of all pumps shall be provided locally and to the PLC.
 - c. Mixer remains in ON position at all times.
 - d. The feed pumps shall run off a 4 mA to 20 mA stroke adjustment. The command shall be provided by the water treatment plant's SCADA system to the Lime System PLC. Local manual operation of the feed pumps shall also be available at the Lime Control Panel LCP-650.
 - e. An alarm light shall be provided on the local Lime System PLC Panel and a local audible mixer alarm shall be energized if there is power failure to the mixer. This fault signal shall be readable from the Lime System PLC by the plant SCADA system via Ethernet.

- f. Level indication and transmitters for the tank shall be provided locally and to the Lime System PLC. This signal shall be readable from the Lime System PLC by the plant SCADA system via Ethernet.
- g. Individual pump discharge pressure shall be provided locally and to the Lime System PLC. This system shall be readable from the Lime System PLC to the plant SCADA system via Ethernet.
- 6. I/O contacts for internal and external signals shall be provided as listed.

C. Panels:

- 1. Discrete Input signals to Plant PLC/SCADA system (read from PLC panel via Ethernet):
 - a. Panel Power ON.
 - b. Bulk Lime Slurry Tank Mixer ON.
 - c. Lime Slurry Tank Mixer FAULT.
 - d. Lime Feed Pump 1 RUNNING.
 - e. Lime Feed Pump 2 RUNNING.
 - f. Lime Feed Pump 3 RUNNING.
 - g. Lime Feed Pump 4 RUNNING.
 - h. Lime Feed Pump 1 FAULT.
 - i. Lime Feed Pump 2 FAULT.
 - j. Lime Feed Pump 3 FAULT.
 - k. Lime Feed Pump 4 FAULT.
 - l. Lime Feed Pump 1 IN HAND/OFF/AUTO.
 - m. Lime Feed Pump 2 IN HAND/OFF/AUTO.
 - n. Lime Feed Pump 3 IN HAND/OFF/AUTO.
 - o. Lime Feed Pump 4 IN HAND/OFF/AUTO.
- 2. Discrete Output signals from Plant PLC/SCADA system (Write to Lime System PLC Panel via Ethernet):
 - a. Run command to Lime Feed Pump 1.
 - b. Run command to Lime Feed Pump 2.
 - c. Run command to Lime Feed Pump 3.
 - d. Run command to Lime Feed Pump 4.
- 3. Analog Input signals to Plant PLC/SCADA system (read from PLC panel via Ethernet):
 - a. Bulk Lime Slurry Tank Level.
 - b. Lime Feed Pump 1 Discharge Pressure.
 - c. Lime Feed Pump 2 Discharge Pressure.
 - d. Lime Feed Pump 3 Discharge Pressure.
 - e. Lime Feed Pump 4 Discharge Pressure.
- 4. Analog Output signals from Plant PLC/SCADA system (Write to Lime System PLC via Ethernet):
 - a. Lime System Pump 1 Stroke (0-100 percent).
 - b. Lime System Pump 2 Stroke (0-100 percent).
 - c. Lime System Pump 3 Stroke (0-100 percent).

- d. Lime System Pump 4 Stroke (0-100 percent).
5. All analog signals terminating in control panels shall have appropriate surge suppression devices per Section 40 99 00, Package Control Systems.
6. Manufacturer shall provide all interfaces necessary at each control panel to meet the functional requirements specified.

D. Instruments:

1. Provide a Level Transducer/transmitter with 6-inch flanged mounted transducer and transmitter for tank level.
2. Provide a pressure transducer/transmitter for each pump discharge pressure.
3. Surge suppressors shall be provided for all analog instruments per Section 40 99 00, Package Control Systems.

2.11 PAINTING

- A. Pumps, motors, drives, frames, baseplates, room enclosures, and appurtenances shall receive coating as specified by manufacturer for chemical feed (lime slurry) service.
 1. The tank dome, wall exterior, and appurtenances shall be prepared by SP-6 commercial sandblast followed by one coat of Time-Lock Mopoxy IR High Solids Epoxy Coating of #41 Series. Field painting of dome and wall exterior shall be one coat of Rus-Kil H20 Acrylic DTM Coating.
- B. Machined, polished and nonferrous surfaces, except stainless steel, shall be coated with epoxy corrosion preventative compound.

2.11 TOOLS, SPARE PARTS, AND MAINTENANCE MATERIALS

- A. The lime slurry feed system shall be furnished with the following spare parts for each water treatment plant:
 1. One set of metering pump recommended spare parts for each model provided.
 2. Two check valve assemblies.
 3. One complete set of gaskets and seals.
 4. For this set of pumps, furnish one complete set of any special tools required to dismantle pump.
 5. Lubricating oil to bathe the hose during operation.
- B. Spare parts shall be packed in sturdy containers with clear indelible identification markings and shall be stored in a dry, warm location until transferred to the Owner at the completion of the Contract.

- C. Furnish an initial supply of all greases and lubricants required to start operations. Supply an amount of these materials equivalent to 1 year of continuous operation.

2.12 SPECIAL PROJECT REQUIREMENTS-ELECTRICAL COORDINATION

- A. Manufacturer shall provide all starters, contactors, breakers, fuses, and any other ancillary equipment required to meet the functional requirements of the Specification. The manufacturer shall provide and install all cable and conduit between all equipment provided. The Contractor shall be required to provide a single 480V, three-phase, 60A feed to Panel LCP-650. All cable and conduit required to power all instrumentation, lights, pumps, and other equipment shall be provided and installed by the manufacturer.
- B. Provide one 20A, 120V GFI protected circuit breaker installed in LCP-650 to power heat trace on safety shower located outside lime system enclosure.
- C. All cable and conduit to be utilized shall meet all the requirements of Division 26, Electrical, and shall be submitted for approval before procurement.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Installation of the lime slurry tank, enclosure, metering pumps, and appurtenances shall be in accordance with the Drawings and with the system manufacturer's instructions and recommendations. Conflicts of information shall be called to the attention of the Engineer.
- B. Inspect all concrete pads for proper elevation, dimensions, cutouts, evenness and anchor bolt locations and correct if necessary.
- C. Installation shall include furnishing and applying an initial supply of lubricants recommended by the manufacturer.
- D. Interconnecting piping and electrical/instrumentation wiring between the tanks and pumps and control panels is the responsibility of the manufacturer.
- E. Support piping independent of equipment. Equipment shall be free from all loads and stresses induced by the piping.
- F. All equipment including motors, belts and drives shall be aligned to the best industrial standards. Field check and adjust all equipment alignments in the presence of the Engineer.

- G. Inspect all equipment prior to installation. If damaged, notify the Engineer and manufacturer promptly. Do not install damaged equipment until repairs are made in accordance with manufacturer's written instruction and approval by the Engineer.
- H. Make all electrical connections in conformance with the requirements of Division 26, Electrical.
- I. All installation shall be in strict compliance with the equipment manufacturer's written instructions. All anchor bolts and other items placed in the concrete structure shall be located according to certified prints furnished by the manufacturer, as approved by the Engineer. All electrical connections shall be made in accordance with the National Electric Code (NEC).
- J. The pump enclosure shall be delivered to the Site as a package unit with pumps, control panels, water meter, wiring and piping pre-assembled at the Factory. Field erection requirements of the chemical system shall include, but not be limited to, items listed below:
 - 1. Set tank on foundation, level, and anchor.
 - 2. Assemble and install ladder and handrail on tanks.
 - 3. Connect water supplies to water supply fittings.
 - 4. Connect slurry lines to fitting and run slurry lines to injection points
 - 5. Connect all interconnecting piping between tanks, pumps, and injection points
 - 6. Connect 480-volt, three-phase, 60-Hertz power to service entrance panel.
 - 7. Install tank level indicator and install mixer shaft and impeller.

3.02 FIELD PAINTING

- A. Final field painting of the tank dome and exterior wall shall be by Contractor. Field painting shall be one coat of Rus-Kil H20 Acrylic DTM Coating #310-09 and one finish coat of Rus-Kil H20 Acrylic DTM coating #310-16.

3.03 STARTUP AND TEST

- A. Contractor and system manufacturer shall verify that structures, equipment, pumps and motors are compatible for an efficient system.
- B. Contractor and system manufacturer shall make equipment adjustments required to place system in proper operating condition.

- C. Test the lime slurry feed system for proper operation in the presence of the Owner.
- D. Furnish all testing equipment and devices required.
- E. If the lime slurry feed system fails to meet any of the specified performance requirements, Contractor shall modify and/or replace defective equipment until it meets specified requirements. Retest system to verify satisfactory operation.
- F. Demonstrate the accuracy of each metering pump based on the ability to respond to the control signal. Provide pump curves showing liquid output at the full range of stroke length and stroke speed.
- G. After installation of storage tank is complete, but before piping connections are made, block all outlets and fill the tank with water to check for leaks. No leakage will be permitted. Drain water and clean outside of tank and nozzles.
- H. The Lime Feed System Manufacturer's Field Services at each of the two water treatment plants:
 - 1. Retain, for a period of 2 days, factory trained representatives of the manufacturer with demonstrated ability and experience in the installation and operation of the equipment to perform the services listed below. One of the two field service days at each site shall be provided during the installation phase of the equipment:
 - a. Inspect the completed installation and prepare an inspection report.
 - b. Test, calibrate, and adjust all components for optimum performance.
 - c. Assist in initial startup and field testing.
 - d. Instruct Owner's personnel in the operation and user maintenance of all components. Conduct a training seminar at the Site.
 - e. Supervise the correction of any defective or faulty work before and after acceptance by Owner.

3.04 SUPPLEMENT

- A. The supplement listed below, which follows "End of Section," is part of this specification.
 - 1. Supplement 1: Burnett Lime Company, Inc., proposal document.

END OF SECTION

CAL~FLO® LIME SLURRY SYSTEM US PATENTED
CROSSTOWN WTP IMPROVEMENTS AND
SOUTH FAYETTE WTP IMPROVEMENTS
FAYETTE COUNTY, GEORGIA

General:

Scope:

The manufacturer shall furnish and install one complete bulk slurry storage system and feed system as specified herein and as shown on the drawings for each of the locations mentioned above. The equipment shall be fabricated, erected, assembled and placed in proper operating condition in full conformity with the drawings, specifications, instructions and recommendations of the equipment manufacturer. The *systems* shall be as manufactured by **Burnett Lime Company, Inc.**

Manufacturer:

The bulk slurry chemical system manufacturer/supplier shall be **Burnett Lime Company, Inc.**, Campobello, South Carolina.

Each entire bulk slurry chemical system will 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 take sole responsibility for procurement, installation and testing the products incorporated in the package.

Qualifications:

The equipment manufacturer of the bulk slurry chemical system shall be one who is regularly engaged in the business of designing and building chemical handling systems. Manufacturers not named in this specification shall verify their qualifications for designing, furnishing, and coordinating the chemical system by furnishing the **Owner**, prior to the bid date, information meeting the criteria listed below under items 1 through 8:

1. The equipment manufacturer shall have the required financial capability to complete the project.
2. The equipment manufacturer shall furnish names of manufacturers whose products are normally supplied and the type of business relationship with each.
3. The equipment manufacturer shall maintain a qualified technical and design office.
4. The equipment manufacturer shall have a physical plant and personnel to complete the work specified.
5. The equipment manufacturer shall maintain competent service personnel to service the equipment furnished.
6. The equipment manufacturer shall have successfully provided similar work for at least five years.

CAL~FLO® LIME SLURRY SYSTEM US PATENTED
CROSTOWN WTP IMPROVEMENTS AND
SOUTH FAYETTE WTP IMPROVEMENTS
FAYETTE COUNTY, GEORGIA

7. The equipment manufacturer shall furnish at least five references who are users of similar systems designed, fabricated, and furnished by the equipment supplier.
8. Manufacturer must have the capability to install a pilot test unit in order to provide functional data to prove system claim and complete a successful plant trial for **Fayette County, Georgia** prior to bidding.
9. The lime slurry system shall be NSF/ANSI 61 certified.

Project Description:

Burnett Lime Company, Inc. proposes to provide a US Patented CAL~FLO® Standard Lime Slurry Storage and Delivery System designed with one 16,000-gallon storage tank and metering pumps as described herein for *each* system. The Pump and Control Systems are pre-assembled and factory tested at our manufacturing facility prior to shipping.

- A. *Each* Tank will be shipped directly from the manufacturer, received by **Burnett Lime Company** in coordination with the Pump and Control Enclosure and set on the concrete pad provided by the **Owner /General Contractor**.
- B. *Each* The Pump and Control Enclosure will be transported to the site by our technicians and set into place in conjunction with the 16,000-gallon storage tank.
- C. **Burnett Lime Company's** installation and startup technicians will provide all final terminations and system extensions.
- D. **Burnett Lime Company** will provide both startup and technical training for the operators. Specific operational procedures, reporting and safety training will be the responsibility of the **Owner**.

1.0 System Description:

1.01 Lime Slurry Tank

- A. Tank shall be single compartment, welded steel reinforced top, having a nominal capacity of 16,000 gallons and a maximum diameter of 12 feet.
- B. Tank shall be fabricated using steel as specified by ASTM A36.
- C. Tank design shall be in accordance with AWWA D100 with minimum top and bottom plate thickness of ¼-inch and minimum wall plate thickness of 3/16-inch.
- D. Tank appurtenances shall be as follows (reference to tank drawings for preliminary orientation):

CAL~FLO® LIME SLURRY SYSTEM US PATENTED
CROSTOWN WTP IMPROVEMENTS AND
SOUTH FAYETTE WTP IMPROVEMENTS
FAYETTE COUNTY, GEORGIA

1. 12-inch mixer mounting nozzle (top)
2. 24-inch atmospheric manhole / inspection port (top)
3. 24-inch manhole (3-1/2 feet above bottom)
4. 6-inch nozzle (pump suction, 9-inches above bottom)
5. 6-inch nozzle (pump suction, 9-inches above bottom)
6. 6-inch nozzle (pump suction, 9-inches above bottom)
7. 6-inch nozzle (pump suction, 9-inches above bottom)
8. 3-inch nozzle (drain with hose bib, 2-inches above bottom)
9. 4-inch threaded connection (overflow, 6-inches below top)
10. 2-inch nozzle (spare, top)
11. 6-inch nozzle (level sensor – 18-inches off wall, top)
12. 2-inch nozzle (water fill, top)
13. 2-inch nozzle (slurry fill, top)
14. 3-inch nozzle (re-circulation)
15. Four 10-inch wide by long 18 feet gusseted baffles fabricated from 1/4-inch plate positioned 1-inch off the wall
16. Six Anchor lugs
17. Ladder, ladder cage and full tank perimeter handrail (shall be of carbon steel)
18. Standoff pipe supports and clamps (maximum 8 feet on center for overflow, slurry and water lines)
19. Lift lugs (2)
20. Fill pipe (2-inch), with quick-connect
21. Overflow pipe (4-inch) with weighted cover to prevent insect entry
22. Six 3/4" x 16" stainless epoxy anchors furnished and installed by **Burnett Lime Company**

E. Surface Preparation and Painting.

1. The exterior of tank dome, wall and appurtenances shall be prepared by commercial sandblast followed by one coat of MoPoxY™ ST High Solids Epoxy Coating 41-series: component A - 41-BK-1 and component B - A41-EF-3 by Tank Manufacturer. **Field painting, by the General Contractor**, of exterior dome and wall shall be one coat of H₂O RUS-KIL® ACRYLIC DTM Rust Resistant Primer 310-series: #310-09 and one finish coat of H₂O RUS-KIL® ACRYLIC DTM Rust Resistant Coating #310-series: #310-16.

CAL~FLO® LIME SLURRY SYSTEM US PATENTED
CROSTOWN WTP IMPROVEMENTS AND
SOUTH FAYETTE WTP IMPROVEMENTS
FAYETTE COUNTY, GEORGIA

2. Tank Manufacturer shall coat the bottom of the tank with coal tar epoxy: Mo-Tar™ C-200 Epoxy Coating.

1.02 Feed Pump Enclosure

- A. **Each** pump enclosure shall be a nominal 10ft-4in. x 10ft-6in., metal building with the tank shell forming one wall. The minimum clear height of the enclosure shall be 7ft.-6in.
- B. **Each** pump enclosure building shall be Stainless Steel Frame (1 ¼" Stainless Steel Tube) with 3" vinyl backed insulation. The gauge 26 exterior wall panels, roof panels and flashings shall be coated with a factory finish of Valspar Corporation Polar White PMW1614 (MBCI Signature 200) minimum .8 mil over a minimum .2 Valspar Corporation Dynaprime primer.
- C. The enclosure accessories shall include:
 1. One 36-inch by 78-inch access door with stainless steel hardware.
 2. One 1500-watt UL-listed heater with thermostat range of 45° to 135°F and on-off switch as manufactured by Qmark/ Marley CRA1512-T2.
 3. One, Dayton Model 1BLH6, 120-volt fan having minimum free air capacity of 520 CFM. The fan shall be thermostatically controlled with a set point of 85° F. The fan shall be fitted with a wire guard and removable interior vent door. Provide manually adjustable FRP air intake vent with FRP screen.
 4. Interior lighting shall be by one, 4-foot long, 2-lamp, surface-mounted, fluorescent fixture controlled by weatherproof interior switch.
 5. Provide one 120-volt interior GFI Type outlet with gasketed, spring-loaded cover.
 6. All lighting, heater, ventilation, switches and outlets shall be pre-wired using 3-wire, color-coded, #12 THHN copper wire in PVC Schedule 80 conduit.
 7. Provide lime system tank and pump enclosure with grounding lugs.
 8. One Bradley Model S19-310TW8 Shower and Eyewash just outside door with piping through wall.

1.03 Controls

1.03.1 Lime Control Panel (LCP-650)

- A. All motor starters, relays, timers and devices for the control and operation of the equipment shall be housed in a control panel. A PLC within the Control Panel shall provide remote signal/equipment interface with the plant system via **Contractor** supplied Ethernet cable.

CAL~FLO® LIME SLURRY SYSTEM US PATENTED
CROSTOWN WTP IMPROVEMENTS AND
SOUTH FAYETTE WTP IMPROVEMENTS
FAYETTE COUNTY, GEORGIA

- B. The CAL~FLO® Lime Slurry system with PLC is designed to be a Stand-alone manually operated self-contained lime delivery system or may be remotely operated from a plant SCADA System via Ethernet cable provided by the **Owner/General Contractor** to the **Burnett Lime** supplied Allen-Bradley 1761 NET-ENI Ethernet module. A list of addresses shall be provided to the plant HMI programmer for status display. Remote inputs to the Lime System are necessary for the stroke adjustment (0-100%). This stroke adjustment is generally calculated by the plant's own HMI system, based on flow rates, pH, anticipated lime needs, etc as a 0-100% value of stroke adjustment. The CAL~FLO® Lime Slurry System PLC shall be Micrologix 1500 as manufactured by Allen-Bradley.
- C. Power Supply: The **Owner/General Contractor** shall provide a 480 VAC, three-phase power feed to the flange-mounted circuit breaker located in the lime system control panel. All controls shall operate on 120 VAC maximum. A 3000 VA control power transformer with primary and secondary over current protection will be provided.
- D. Enclosure: NEMA 4X 304 SS, bottom entry, flange-mounted disconnect. A grounding lug is provided within the panel to assure positive system ground.
- E. Components
1. Circuit Breaker: Isolation Breaker for the Panel shall be a 60 Amp Type M breaker /ITED 43B060L or equal.
 2. Starters and Motor protection: Pump motor will controlled and protected by Allen-Bradley Model AB100C and AB140MC2, Type E self protected manual starter with adjustable amperage breaker. Motor Protection shall conform to IEC Circuit Breaker requirements as defined by IEC 947-2 and UL/CSA listed.
 3. Relays: Relays shall be general-purpose control type, 10 amps, 600-volt reversible contacts. Relays shall be equal to Allen-Bradley, Pump 700, and Type H.
 4. Selectors: 30.5 mm, NEMA 4X rated; contacts shall be rated 10 amps continuous, 6 amps breakers at 120 VAC, manufactured by Allen-Bradley, Type 800H.
 5. Weatherproof Horn: Horn shall generate a loud audible alarm when activated by 115 VAC power. The horn shall surface mount with sealable side conduit entry and shall be rated for NEMA 4X. Horn shall be equal to Federal, Model 350W.
 6. Indicator Lights: Provide Green run 30.5 mm transformer type LED indicator lights as equal to Allen-Bradley type 800H for each motor.

CAL~FLO® LIME SLURRY SYSTEM US PATENTED
CROSTOWN WTP IMPROVEMENTS AND
SOUTH FAYETTE WTP IMPROVEMENTS
FAYETTE COUNTY, GEORGIA

- 7. High Level indicator light and Reorder indicator light: Provide Red 30.5 mm transformer type LED indicator lights as equal to Allen-Bradley type 800H.
- F. Panel Construction: All wiring across panel hinges shall be protected by a plastic enclosure. Terminal strips will be numbered for all field-wiring terminations.
- G. Engraved Nameplates: Engraved nameplates with white background and black letters on all front panel-mounted devices.
- H. Surge Protection: All AC power wiring shall be protected against lightning spikes and other transient surges at all control panel termination points. Protection shall be as manufactured by Siemens TPS series.
- I. Cater pump control shall be provided for managing the high and low pressure status each of the lime slurry pumps. A red indicator light for high/low pressure alarm and the Red Lion digital readout are located on the door of the Lime Control Panel LCP-650. Pressure shall be read by the system PLC.

1.03.2 Lime Tank – Level Indicator Transmitter (LIT-1)

- A. Lime level control shall be the Milltronics MultiRanger level transmitter and tank level indicator. The level indicator shall produce an audible high level alarm located on the exterior of the pump enclosure and a re-order indicator light located on the exterior of the system control panel. Level signal will be obtained through the lime system PLC 1761-NET-ENI module via Ethernet Cable provided by **others**.
- B. Panel Enclosure shall be a polycarbonate enclosure rated NEMA 4X and shall be located perpendicular to the Control Panel.

1.04 Tank Mixer

- A. **Each** tank mixer shall be vertical, flange mounted with two axial flow, and one radial flow impeller sized and positioned to maintain a homogenous mixture of up to 30% Lime Slurry at ambient temperature. Mixer shall be suitable for operation in a 12' diameter by 19' straight shell atmospheric tank. Mixer configuration drawings are included in this proposal.
- B. The motor shall be furnished by SEW-Euro drive, Inc. specifically for direct mounting to gear reducer. Motor shall be a TEFC, Frame DRE132M4 with a severe duty canopy with the following characteristics:

Horsepower: 7.5
Maximum Speed: 1750 rpm
460 volt, 3-phase, 60 Hz
Continuous Duty
TEFC

CAL~FLO® LIME SLURRY SYSTEM US PATENTED
CROSTOWN WTP IMPROVEMENTS AND
SOUTH FAYETTE WTP IMPROVEMENTS
FAYETTE COUNTY, GEORGIA

- C. A local mixer disconnect switch is located within visible sight of the mixer motor and the top entrance manway to the tank. All tank-mounted conduit shall be PVC schedule 80.
- D. The speed reducer shall be designated for mixing service and operation in an outdoor environment. The rating of the speed reducer shall adhere to appropriate AGMA standards and the reducer shall bear an AGMA nameplate.
- E. The speed reducer shall be constructed and supported so that the shaft deflection, caused by operation loads, does not affect alignment of the anti-friction bearings or cause misalignment of gearing during mixer operation. The reducer output shaft bearings shall have minimum rated B-10 life of 100,000 hours.
- F. All reducer bearings shall be severe duty, anti-friction type, oil or grease-lubricated. The speed reducer shall be splash lubricated, by means of gears or a slinger rotating on a horizontal shaft in an oil bath, to ensure positive displacement of the oil upward for lubrication of critical bearings. A single oil drain shall be provided at the low point of the speed reducer to allow oil drainage and leave a maximum residual of oil of no more than 1/4-inch in the drive housing.
- G. The shaft and impellers shall be carbon steel. The maximum operating speed of the unit shall be 0.5 times the natural frequency of the shaft and impeller assembly. The shaft diameter shall be determined by an analysis of torque and bending moment as well as critical speed. Minimum shaft diameter shall be 3 inches. The shaft supporting the turbine shall be removable from the speed reducer without disturbing the gears of the speed reducer using a rigid flange coupling on the impeller shaft.
- H. The mixer shall be Tesco Model LSM-16-20 with motor and Eurodrive F series gear reducer.

1.05 Slurry Feed Pumps

- A. Four Feed Pumps for each system shall be a tubular diaphragm type, maximum rated delivery capacity of 25.55 gph for Crosstown and 11.68 gph for South Fayette, *each* at 40 psig while operating at a service speed of 116 spm. Pumps shall have a minimum turndown ratio of 10 to 1 by variation of the stroke of the pump. Capacity shall be adjusted by manually changing piston stroke length or by automatic stroke adjustment.

For CAL~FLO® Lime Slurry Systems with a System PLC, the pump selector switch is placed in Auto, ready to receive a remote input signal (0-100%) from the remote plant integrations system to the Lime system PLC 1761-NET-ENI Ethernet Card via Ethernet interface provided by the **Owner/General**

CAL~FLO® LIME SLURRY SYSTEM US PATENTED
CROSTOWN WTP IMPROVEMENTS AND
SOUTH FAYETTE WTP IMPROVEMENTS
FAYETTE COUNTY, GEORGIA

Contractor. The CAL~FLO® system PLC shall send the 4-20mA corresponding input to the metering pump to adjust the stroke length 0-100 percent and provide an output signal back to the CAL~FLO® System PLC for monitoring. **Remote connection via Ethernet cable provided by Owner/General Contractor.**

- B. The motor shall be Baldor as required by pump size and shall have the following characteristics:

Horsepower: ½
460 volt, 3-phase, 60 Hz
TEFC: Continuous Duty
Service Factor 1.15

- C. Pumps shall be mounted on a steel base plate and secured to the floor of the enclosure.
- D. Pumps shall be Pulsafeeder Model 7120.

1.06 Chemical Feed Lines

The slurry feed lines shall be accessible in a PVC conduit (conduit provided **by the Owner/General Contractor**). The feed tubing to the Feed Point shall be either ¼", 3/8", ½", 5/8" or ¾" ID clear flexible reinforced PVC hose (as determined by manufacturer) and shall be equal to Kuri Tec Series #K3150.

1.07 Valves and Appurtenances

- A. Water isolation valves shall be true union PVC Ball Valves.
- B. Automatic Flush valves shall be true union, 3-way actuated stainless steel Ball Valves.
- C. Provide one ¾-inch hose bibb on water supply header.
- D. Isolation valves for liquid lime service shall be 2-inch flanged, pinch valves, ONYX Controls or equal. There are two limit switches on all pinch valves. One limit switch is interlocked in the pump run circuit to assure positive position of the valve for pump protection. The second limit switch is to provide a water flush on system shutdown.
- E. Water meter shall be 2-inch, BadgerMeter Recordall Disk Meter positive displacement AWWA approved water meter with BadgerMeter Recordall Transmitter Register (RTR). The water meter shall have maximum range of 170 gpm.
- F. Drain and recirculation lines shall have 3" Butterfly valves with quick-connects.
- G. Connections for Shower/Eyewash through wall.

CAL~FLO® LIME SLURRY SYSTEM US PATENTED
CROSTOWN WTP IMPROVEMENTS AND
SOUTH FAYETTE WTP IMPROVEMENTS
FAYETTE COUNTY, GEORGIA

1.08 Instrumentation

- A. Level Transducer/ transmitter shall be a 6" flange mounted transducer as manufactured by Milltronics model XPS15. The level display Milltronics MultiRanger shall be mounted perpendicular to the control panel.
- B. A pressure transducer /transmitter indicator shall be as manufactured by Endress Hauser and provided for each pump discharge line. Red Lion Indicators shall mount in the door of the control panel.
- C. A Dilution Water Control Panel (DWCP) shall be mounted near the water Meter consisting of a NEMA 4X Enclosure housing a Red Lion PAXI digital readout and a start/pause pushbutton Allen Bradley Model 800H. Connection shall be made to the Badger Meter Recordall Water Meter with Recordall Transmitter Register (RTR).

1.09 Spare Parts

One KopKit per pump size will be provided for each system.

Note: The model numbers indicated above are to establish quality and Burnett Lime Company reserves the right to provide equivalent components in the submission of the approval process.

2.0 Execution

2.01 Installation:

All installation shall be in strict compliance with the manufacturer's written instructions. All anchor bolts placed in the concrete structure shall be located, drilled and installed in place with epoxy according to the manufacturer, as approved by the Engineer. All electrical connections shall be made in accordance with the National Electric Code (NEC).

2.02 Manufacturer's Service:

- A. Furnish the services of a factory representative for one, eight-hour day during the installation phase of the equipment. The factory representative shall have full knowledge and experience in the installation of the type of equipment being installed.

- 2.03** Furnish the services of a factory representative, having complete knowledge of proper operation start-up procedure and maintenance requirements, for one, eight hour day, to inspect the final installation, supervise a test run of the equipment and instruct the **Owner's** personnel in the proper operation of the system.

CAL~FLO® LIME SLURRY SYSTEM US PATENTED
CROSTOWN WTP IMPROVEMENTS AND
SOUTH FAYETTE WTP IMPROVEMENTS
FAYETTE COUNTY, GEORGIA

2.04 Manufacturer's System Warranty:

The manufacturer shall warrant that all supported materials and components will function as specified and be free from defects in manufacturing, design and fabrication for a period of one year after the system is placed in operation.

Equipment components and accessories manufactured by others but purchased through **Burnett Lime Company, Inc.**, such as electric motors, valves and other controls, are guaranteed only to the extent of coverage offered by their original manufacturer.

Expressly excluded from the warranty are defects caused by misuse, abuse, or improper applications, employment, or operation of the unit. The warranty does not cover acts of God, such as, lightning, explosion, fire, and flood or terrorist acts.

This warranty does not extend to damage caused by day-to-day operation considered normal wear items, such as tubes, seats, diaphragm etc. Equipment, such as tank, mixer, pumps, and associated electrical equipment, is covered under this warranty, and if the equipment requires repair or replacement as a result of ordinary wear and tear under normal conditions, **Burnett Lime Company** will repair or replace such equipment as required without cost to the Owner.

Alterations or changes to the **Burnett Lime Company** CAL~FLO® system and/or slurry without approval from Burnett Lime could void the warranty.

THE SLURRY: The delivered slurry concentration will be 30% and the system will feed an established dilution of the delivered concentrate. Strict quality control from the manufacturer is important to the smooth operation of the CAL~FLO® system. Consequently, carbide limes and generic slurries may have coarse inert particles that could interrupt chemical feeding.

SLURRY SPECIFICATIONS: Calcium hydroxide shall be a stabilized 30% aqueous suspension with a Specific Gravity between 1.19 and 1.23 g/ml. The Supplier shall certify no quicklime is used in the slurry manufacturing process and only finely ground air-classified hydrated lime for preparation of the slurry product. The slurry solids will have 99% or higher passing 100 mesh screen. Slurry product must be ANSI/NSF standard 60 certified. Delivery tankers shall be solely used for shipping slurry and equipped with a system to avoid spillage during the off-loading. Delivery driver shall be responsible for proper dilution and request inspection by the on-site operator. Generic lime slurries can have large particulates that would require costly removal from the system storage tank, the supplier will guarantee the function of the patented, installed CAL~FLO® system from storage tank sediment and line stoppage with CAL~FLO® Slurry and the prior listed specifications.

The above warranty is in lieu of any other guarantee, either expressed or implied. Burnett Lime's total liability under any circumstance shall not exceed the original purchase price of the equipment component in question and does not extend to any consequential damages or attorney fees that may result in the need for the replacement of nonconformity components.

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CROSTOWN WTP IMPROVEMENTS AND
SOUTH FAYETTE WTP IMPROVEMENTS
FAYETTE COUNTY, GEORGIA

2.05 Cleaning:

All reactors will be cleaned of all debris prior to factory test. **Burnett Lime Company** will clean and remove from site all excess construction material utilized in the installation of the CAL~FLO® System.

2.06 Startup:

Burnett Lime Company will conduct a site acceptance test upon the completion of the installation. Tests will be conducted using water as the testing media. **Owner/General Contractor** shall be responsible for the providing and disposal of the Water, and the providing of the power from either the permanent or temporary source.

3.0 Work By General Contractor:

- A. Foundations, floor slabs, grating and electrical conduit in slab.
- B. Grounding for the pump enclosure and tank.
- C. All drainage from floor drains.
- D. Curbs and containment structures.
- E. 480V, 3ph, 60 Amp power to the power panel and terminating in the power panel.
- F. All communication cable /wiring from the Plant SCADA to the Lime System PLC.
- G. 2" Valve service water connection including backflow prevention and customer service connection to the pump enclosure building.
- H. All trenching, feed line conduit, open trenching, wall sleeves coring, and tapping.
- I. Final Painting of Tank.
- J. Service water pressure not to exceed 70 pounds to the CAL~FLO® system.

CAL~FLO® LIME SLURRY SYSTEM US PATENTED
CROSSTOWN WTP IMPROVEMENTS AND
SOUTH FAYETTE WTP IMPROVEMENTS
FAYETTE COUNTY, GEORGIA

Compensation

Burnett Lime Company is pleased to provide the afore described Lime Slurry System including all material and labor necessary for a complete operating system for:

CAL~FLO® SYSTEM - CROSSTOWN WTP IMPROVEMENTS:

| | |
|--------------------------------|----------------------|
| CAL~FLO® Equipment Price | \$ 243,725.00 |
| Freight With Escort..... | \$ 3,200.00 |
| Installation..... | \$ 7,000.00 |
| Cost Before Tax..... | \$ 253,925.00 |

Sales tax not included.

CAL~FLO® SYSTEM – SOUTH FAYETTE WTP IMPROVEMENTS:

| | |
|--------------------------------|----------------------|
| CAL~FLO® Equipment Price | \$ 243,725.00 |
| Freight With Escort..... | \$ 3,200.00 |
| Installation..... | \$ 7,000.00 |
| Cost Before Tax..... | \$ 253,925.00 |

Sales tax not included.

COST FOR BOTH SYSTEMS

| | |
|---|----------------------|
| Subtotal For Both Systems Before Tax | \$ 507,850.00 |
| State Tax if Applicable: | \$ _____ |
| Estimated Total Cost: | \$ _____ |

Pricing good for 60 days from proposal date.

This quotation is to provide our standard system as described herein. Variation in design components may cause a change in price and delivery.

Sales tax not included.

SECTION 44 44 13.01
CHEMICAL METERING PUMPS

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): 112, Standard Test Procedure for Polyphase Induction Motors and Generators.
2. Hydraulic Institute Standards.
3. National Electrical Manufacturer's Association (NEMA): MG 1, Motors and Generators.

1.02 DEFINITIONS

A. Terminology pertaining to pumping unit performance and construction shall conform to the ratings and nomenclature of the Hydraulic Institute Standards.

1.03 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
 - a. Make, model, weight, and horsepower of each equipment assembly.
 - b. Complete catalog information, descriptive literature, specifications, and identification of materials of construction.
 - c. Performance data on pumps, including curves showing flow rate as a function of RPM over the entire operating range of the pump. Include required horsepower demand over the entire flow range.
 - d. Pump data sheet confirming pump capacity in gallons per hour and pressure in psig, required backpressure valve setting, materials, testing requirements, and appurtenances to be provided with pumps.
 - e. Detailed Mechanical and Electrical Drawings showing equipment dimensions, size, mounting requirements, piping connection sizes and locations, and weight.
 - f. Power and control wiring diagrams, including terminals and numbers.
 - g. Complete motor nameplate data, as defined by NEMA, motor manufacturer, and including any motor modifications.
 - h. Manufacturer's materials compatibility information, confirming compatibility of wetted parts with specified pumped chemicals.

- i. Factory finish system.
- 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 Certificate of Compliance that factory finish system is identical to requirements specified herein.
- 3. Factory test reports.
- 4. Special shipping, storage and protection, and handling instructions.
- 5. Manufacturer's printed installation instructions.
- 6. Suggested spare parts list to maintain the equipment in service for a period of 1 and 5 years. Include a list of special tools required for checking, testing, parts replacement, and maintenance with current price information.
- 7. List special tools, materials, and supplies furnished with equipment for use prior to and during startup and for future maintenance.
- 8. Operation and Maintenance Data: As specified in Section 01 78 23, Operation and Maintenance Data.
- 9. Manufacturer's Certificate of Proper Installation, in accordance with Section 01 43 33, Manufacturers' Field Services.

1.04 EXTRA MATERIALS

A. Furnish for this set of pumps:

- 1. Three tubing elements of specified size and material.
- 2. One pump head.
- 3. One complete set of any special tools required to dismantle pump.

PART 2 PRODUCTS

2.01 GENERAL

A. Acceptable Manufacturers.

- 1. Watson-Marlow Brendel.
- 2. Approved equal.

2.02 SUPPLEMENTS

A. Specific requirements are attached to this section as supplements.

2.03 PUMP

- A. Pump shall be positive displacement peristaltic type, capable of running dry without damage to the pump or tube. Pump shall be dry, self-priming, and capable of a maximum suction lift of 30 feet vertical water column. Pump shall have no internal valves or glands and shall not require dynamic seals in contact with the pumped liquid.
- B. Each pumping unit shall be complete with an integral self-contained variable speed drive and shall be mounted on a shelf for freestanding operation.
- C. Must be capable of operating in both directions.
- D. Process fluid shall be contained within tubing and shall not directly contact any rotary or metallic components during normal operation.
- E. All components that could be exposed to chemical must be suitable for use with that chemical.
- F. Pump head:
 - 1. One roller shall be fully engaged with the tubing at all times to provide complete compression while preventing back flow or siphoning.
 - 2. Rotation direction must be verifiable visually during normal operation of the pump.
 - 3. Shall be 24-hour continuous duty rated.
 - 4. For the instance where a tube fails, a sealed leak containment area is required. Containment must have some method of controlled draining.
 - 5. Pump heads requiring disassembly or special tools for tube replacement are not acceptable.
 - 6. Pump heads with track angle of less than 180 degrees are not acceptable.
- G. Tubing and Hose:
 - 1. Tubing Element:
 - a. Provide each pump with tubing element of a size and material appropriate for service, as specified in pump data sheets.
 - b. Element is to be installed inside the pump without the use of special tools or disassembly of the pump head.
 - c. Both ends of the tubing element shall be constructed with male fitting connections.
 - 2. Hose:
 - a. Provide each pump with two, 1-meter lengths of reinforced, flexible, PVC hose.

- b. Hose will connect to both ends of the tubing element via a female fitting connection. Female connection to include built in shutoff valve for easy maintenance and connection.
- c. Other end of PVC hose shall be constructed with male NPT fitting for connection to process piping. See Drawings for process line size.
- 3. Fitting connections shall be suitable for use with the specified chemical and at pump's maximum pressure.

H. Drive:

- 1. Shall be rated for 24-hour continuous operation.
- 2. Power Supply: 120V, 60-Hz, single-phase. Supply 3-foot power cord with standard three-prong plug. Maximum power consumption shall be 135 VA.
- 3. Mounting: Drive shall be self-supporting and shall not require anchoring.
- 4. External Interfaces:
 - a. Discrete Input(s): Pump RUN command.
 - b. Discrete Output(s):
 - 1) Pump ON status.
 - 2) Pump IN REMOTE status.
 - 3) Pump FAIL alarm.
 - 4) Hose LEAK detected.
 - c. Analog Input(s): Speed command.
 - d. Analog Output(s): Speed feedback.

2.04 VALVES

- A. Adjustable pressure relief type installed on pump discharge as shown on Drawings and set as recommended by pump manufacturer.
- B. See Section 40 27 02, Process Valves and Operators, for specifics on the valve types.

2.05 PUMP CONTROL

- A. Adjustable Speed Adjustment: Provide adjustable speed operation of pump using DC drive. Coordinate pump motor type with drive unit provided. DC drive shall not cause more than 1 percent harmonic distortion into power supply voltage waveform, as defined by IEEE Standard 519. Furnish isolation transformers or filtering devices as necessary to meet this requirement. Drive unit shall include integral control panel with speed indication in percent, HAND/OFF/AUTO selector switch, and manual adjustable potentiometer for adjustment of pump speed when in HAND position. Drive shall accept external 4-20 mA dc control signal to provide linear adjustment

of pump speed from zero to 100 percent when in AUTO position. Provide DRIVE FAIL, IN REMOTE and ON/OFF discrete output signals. Provide 4-20 mA analog output signal for drive speed.

2.06 ACCESSORIES

- A. Equipment Identification Plate: 16-gauge Type 316 stainless steel with 1/4-inch die-stamped equipment tag number securely mounted in a readily visible location.
- B. Lifting Lugs: Equipment weighing over 100 pounds.
- C. Anchor Bolts: Type 316 stainless steel, sized by equipment manufacturer and as specified in Section 05 50 00, Metal Fabrications. Coat in accordance with Section 09 90 04, Painting.
- D. Pump Support: Provide pump support which can be cantilevered from vertically-mounted unistrut as shown in Drawings. Coordinate with building system supplier as needed for design of pump support.
- E. Pulsation Dampeners: Single diaphragm-type mounted on discharge piping. As shown on Drawings and as recommended by pump manufacturer. Body and diaphragm shall be suitable for designated service.
- F. Calibrated Cylinder:
 - 1. Graduated in 0.05-gallon increments.
 - 2. Size as needed so column capacity is sufficient for one minute of use with associated pump at maximum operational capacity.
 - 3. Constructed of clear polypropylene and PVC, and equipped with a shutoff valve.

2.07 FACTORY FINISHING

- A. Prepare, prime, and finish coat in accordance with Section 09 90 04, Painting.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install in accordance with manufacturer's printed instructions.
- B. Anchor Bolts: Accurately place using equipment templates and as specified in Section 05 50 00, Metal Fabrications.

3.02 FIELD FINISHING

- A. Equipment as specified in Section 09 90 04, Painting.

3.03 FIELD QUALITY CONTROL

- A. Conduct tests on each pump.
- B. Functional Test:
 - 1. Alignment: Test complete assemblies for proper alignment and connection, quiet operation, excessive vibration, and conformance to the service conditions and performance requirements specified herein and on the Data Sheet supplements.
- C. Performance Test:
 - 1. Perform under actual or approved simulated operating conditions.
 - 2. Test for a continuous 3-hour period without malfunction.

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. 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 and prestartup classroom or Site training.
- B. See Section 01 43 33, Manufacturers' Field Services and Section 01 91 14, Equipment Testing and Facility Startup.

3.05 SUPPLEMENTS

- A. Supplement listed below, following "End of Section," are part of this Specification.
 - 1. Supplement 1, Chemical Metering Pump Data Sheet-Sodium Permanganate Feed Pump 1 and 2.

END OF SECTION

CHEMICAL METERING PUMP DATA SHEET, 44 44 13.01Tag Numbers: P-684-1, P-684-2Pump Name: Sodium Permanganate Feed Pump 1 and 2Manufacturer and Model Number: (1) Watson-Marlow Brendel – 520 DU
(2) _____**SERVICE CONDITIONS**Liquid Pumped (Material and Percent): Sodium Permanganate (20%)Pumping Temperature (Fahrenheit): Normal: 70 Max: 104 Min: 50Liquid pH: 6-8Abrasive (Y/N): N Possible Scale Buildup (Y/N): NSuction Pressure (psig): Minimum 3-foot liftAltitude (ft msl): 800 Area Classification: UnclassifiedLocation (indoor/outdoor): Indoor**PERFORMANCE REQUIREMENTS**Capacity (US gph): Maximum: 7.3 Minimum: 0.05Maximum Discharge Pressure (psig): 90Relief Valve Setting (psig/as recommended): Manufacturer Recommended**DESIGN AND MATERIALS**Pump Type: Peristaltic TubeTube Material: Manufacturer RecommendedHousing Material: Manufacturer RecommendedBearing Life (hrs): 30,000Pump Speed Control: Variable

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CHEMICAL METERING PUMP DATA SHEET, 44 44 13.01

Tag Numbers: P-684-1, P-684-2

DRIVE MOTOR

DC brushless motor meeting NEMA Standard MG 1 requirements, rated ambient temperature 50 degrees C, with service factor of 1.15. Furnish direct current motors with Class F insulation, bearings rated ABMA L-10 life of 50,000 hours.

REMARKS: Pumps to include pressure relief valves and calibration column.

PART 4

DRAWINGS
(BOUND SEPARATELY)
